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Environmental Monitoring
Systems Laboratory
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Las Vegas NV 89114

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Williams Air Force Base Air Quality Monitoring

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Appendix

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WILLIAMS AIR FORCE BASE AIR QUALITY MONITORING STUDY.

Appendices,

by

(10) D. C./Sheesley, S. J./Gordon [redacted] M. L./Ehlert
Northrop Services, Inc.
Environmental Sciences Center
Las Vegas, Nevada 89119

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Project Officer

J. L. Connolly
Monitoring Operations Division
Environmental Monitoring Systems Laboratory
Las Vegas, Nevada 89114

Prepared for
Department of the Air Force
Tyndall Air Force Base, Florida 32403

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89114

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FOREWORD

Protection of the environment requires effective regulatory actions based on sound technical and scientific data. The data must include the quantitative description and linking of pollutant sources, transport mechanisms, interactions, and resulting effects on man and his environment. Because of the complexities involved, assessment of exposure to specific pollutants in the environment requires a total systems approach that transcends the media of air, water, and land. The Environmental Monitoring Systems Laboratory at Las Vegas contributes to the formation and enhancement of a sound monitoring-data base for exposure assessment through programs designed to:

- develop and optimize systems and strategies for monitoring pollutants and their impact on the environment
- demonstrate new monitoring systems and technologies by applying them to fulfill special monitoring needs of the Agency's operating programs

This report presents an evaluation of the impact of aircraft operations on air quality at Williams Air Force Base near Phoenix, Arizona. The data reported here will serve as input for defining the accuracy limits of the Air Quality Assessment Model. This program was funded by the Department of the Air Force, Department of the Navy and the U.S. Environmental Protection Agency under an interagency agreement.

Director
Environmental Monitoring Systems Laboratory
Las Vegas, Nevada

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APPENDIX A

PROJECT ORGANIZATION AND IMPLEMENTATION

This appendix provides a chronology of WAFB project events that took place during the planning and implementation of the field monitoring program, including the related special studies. This information is provided for the benefit of the reader whose interest lies at the planning or managerial level as well as to document the events that took place during the implementation of field monitoring efforts.

The basic WAFB monitoring study was implemented by means of an interagency agreement (EPA-IAG-R5-0788) entered into by EMSL-LV and the USAF Civil Engineering Center (AFCEC), with participation from the U.S. Navy Aircraft Environmental Support Office. The Navy was expected to participate by providing funding and technical input through the Air Force.

The interagency agreement established a cooperative study to assess the impact of aircraft emissions on ambient air quality by monitoring two air bases, one Air Force base and one Navy base. EMSL-LV provided monitoring of air quality and meteorological parameters toward the overall goal of model evaluation for Williams AFB. This study was an extension of work being performed by the EPA on "Impact of Airport Emissions."

The original objective was to deteermine the impact of aircraft and air facility-related pollutant emissions on local air quality and to measure that impact over a statistically acceptable period of time. The data provided from the study were used to calculate air quality frequency distributions and to validate existing airport models. The study consisted of three major parts: qualitative definition of impact, assessment of impact, and investigation of model accuracy.

Additinal project tasks were defined in Amendment 1 to the interagency agreement. The agreement reached among the Air Force, EPA, and Navy participants in Boston, Massachusetts, on August 12, 1975, specified equipment and instrumentation purchase modifications. This amendment also provided for related special studies ancillary to the overall program tasks.

A second amendment to the interagency agreement set forth administrative changes within the Air Force program organization and added the report requirements for the one-year measurement effort at Williams AFB.

WAFB PROGRAM ORGANIZATION

Major Peter A. Crowley, chief of the Air Quality Research Division of AFCEC, Kirkland AFB at New Mexico, coordinated the study with WAFB and AF Headquarters Training Command. The EPA Project Officer for this study was Mr. Roy B. Evans, from the Monitoring Operations Division, Air Quality Branch (MOA) at EMSL-LV. Technical direction for monitoring at WAFB was the responsibility of Mr. Karl F. Zeller, a meteorologist from the National Oceanic and Atmospheric Administration (NOAA) assigned to MOA as principal investigator for the study. Lockheed Electronics Company, Inc., under EPA Contract 68-03-2369, performed the assembly, installation, and operation of the monitoring network at WAFB beginning in January 1976 and ending in July 1977, with logistical support provided by AF technical personnel at WAFB. In August 1977, reporting on monitoring operations, data reduction, and data processing to hourly averages for the complete monitoring period was begun by NSI under EPA Contract 68-03-2591.

The Air Force contracted with Argonne National Laboratories (ANL) to compare pollutant frequency distributions as calculated by AQAM to the WAFB data base in order to evaluate the model. ANL is performing the model calculation under various conditions of meteorology and emissions activity. Data on emissions at WAFB from aircraft and other nearby activity were assembled separately from the air quality monitoring, the latter being the responsibility of EMSL-LV. Emissions data for the aircraft mix and activity schedules were provided to the USAF by Stanford Research Institute for use in AQAM model calculations. Any model revisions will be conducted by ANL.

Amendment 2 to the interagency agreement transferred responsibility for participation in the agreement to the U.S. Air Force Civil and Environmental Engineering Development Office (CEEDO) at Tyndall AFB, Florida. Technical project officer responsibility was transferred from Major P. A. Crowley to Captain Dennis F. Naugle.

IMPLEMENTATION OF MONITORING OPERATIONS

Contractor personnel, under EPA guidance, fabricated and installed the monitoring stations and performed system checkout. Monitoring operations and the quality control to maintain operations within acceptable limits were specified by EMSL-LV and MOA and monitored by Mr. Karl F. Zeller, principal investigator of the EPA portion of the WAFB project. Operations activities performed by EPA contract personnel included:

- Liaison between Williams AFB and EMSL-LV personnel
- Maintenance and repair of continuous air quality and meteorological instruments
- Procurement of operating supplies
- Quality control and calibration

- Training of USAF technicians to operate monitoring systems
- Special studies liaison between ANL and EPA principal investigator
- Generation of daily data printouts and instrument charts
- Modification and installation of additional meteorological instrumentation
- Public relations effort and occasional tours of the air quality monitoring network

Activity conducted by EMSL-LV personnel included:

- Project design and technical direction
- Data systems specification and acquisition
- Evaluation leading to modifications in air quality and meteorology hardware
- Preparation of data processing software and specification of data acceptability limits
- Liaison with special interest groups for information and tours

The contractor developed a periodic maintenance procedure and schedules that were followed during monitoring operations. Initially, the EPA trained USAF-enlisted personnel of the 6th Mobile Air Weather Squadron to operate, calibrate, and perform minor maintenance. Periodic rotation of USAF personnel required that additionnal EPA contractor personnel be assigned to assist in training and maintaining continuity of operations. Special studies and data-handling requests from the USAF were coordinated by the contractor with direction from EMSL-LV.

The WAFB monitoring operations were inspected by the EPA during the two months prior to June 1976 to demonstrate that the five mobile stations and the central data acquisition system conformed to the original EPA plan. The inspection consisted of two parts:

1. Reviewing all trailers and central data acquisition equipment to ensure proper procedures for:
    - Stabilization of trailers
    - Physical mounting of instruments and auxiliary equipment
    - Electronic and electrical connections
    - Installation of ambient air sampling manifold
    - Safety practices and procedures

2. Demonstrating valid operation for the Beckman Model 6800 Gas Chromatograph, ML NO/NO_x analyzer, MRI nephelometer, Gill propeller vane, and ML data system through:

   - Calibration
   - Operation in the continuous mode for ambient air sampling
   - Accurate transmission of data from the data acquisition system as voltage printouts for air quality sensor responses to the central data ML 9400 magnetic tape

Some meteorological instruments were added after monitoring operations were started. Contractor personnel performed operation of the acoustic sounder under EPA direction.

APPENDIX B

RELATED SPECIAL STUDIES

The experience gained in earlier airport air quality studies (discussed in Section 1 of this report) had indicated that data from five fixed-site monitoring stations could not be expected to answer all the questions raised by those previous studies. To augment the air quality measurements and to expand on the results to be gained from the five-station air quality network measurements, several short-term studies were carried out. Each study addressed a specific aspect of the overall goal of either monitoring or modeling aircraft pollution. The USAF program and the WAFB study were performed to provide information on the horizontal and vertical dispersion of aircraft emissions and total pollution flux from an operating airbase.

Vertical dispersion was investigated by the static jet study, a scanning laser Doppler velocimeter system (SLDVS) study, and a Barringer correlation spectrometer (COSPEC) study as discussed in Section 4. The acoustic sounder study (Appendix J) also provided information on vertical dispersion through characterization of mixing depth at WAFB. Horizontal dispersion was investigated through a wind dispersion study, the COSPEC study, and a gas-filtered correlation (GFC) spectrometer study.

Remote or long-path air quality measurements were used at WAFB to measure buoyant plume rise of aircraft emissions and to estimate total pollutant flux arising from other sources on the airbase. Remote sensing instrumentation is also useful in measuring the average pollutant concentration over a given path for comparison with model calculations. Most models can be expected to calculate and predict area concentration averages with greater success than specific point averages. Four different techniques of remote sensing were evaluated at WAFB: the SLDVS, the remote optical sensing of emissions (ROSE) system, the COSPEC system, and the GFC spectrometer system.

Each of the following studies was discussed briefly in Section 4, and this appendix contains the indicated additional information on:

- EPA recommendations on the evaluation of AQAM (includes copy of report by Karl F. Zeller).
- Preliminary air quality analysis (1975) (includes copy of report by Karl Zeller and Monty Price)
- Horizontal wind dispersion parameter investigation
- Particle morphology of aerosols collected at WAFB

- The ROSE study
- The COSPEC study
- The GFC spectrometer study
- The SLDVS investigation

EPA RECOMMENDATIONS ON THE EVALUATION OF AQAM

The question basic to the WAFB study was how to actually evaluate or justify an air quality model. No single party to the interagency agreement conducting the study had made a formal recommendation. At the request of the USAF, Mr. Karl Zeller, principal investigator during this study, prepared a recommendation on the subject entitled, "Verification of AQAM. A Complex Air Quality Model Using the Gaussian Dispersion Approach to Estimate the Air Pollution Impact of Air Force Bases." This paper is included in the following pages.

VERIFICATION OF AQAM: A COMPLEX AIR QUALITY MODEL USING THE GAUSSIAN DISPERSION APPROACH TO ESTIMATE THE AIR POLLUTION IMPACT OF AIR FORCE BASES

U.S. Environmental Protection Agency
Office of Research and Development
Environmental Monitoring Systems Laboratory
Las Vegas, Nevada 89114

Mr. Karl Zeller

INTRODUCTION

There is a need to define an acceptable approach for the verification of Gaussian air quality simulation models for multiple source complexes. The demand for answers to air quality questions is so strong that some models have been formulated and applied extensively prior to proper evaluation. Hopefully, proposed models would be subjected to a verification procedure to enable the model developer either to defend a particular use of his model or to indicate possible situations in which his model produces invalid or questionable results.

Each complex Gaussian air quality model is comprised of submodels to describe source emissions, pollutant dispersion and transport, plume rise, source-receptor geometry, and meteorology. In the modeling of complex geometric situations, it is currently necessary to use empirical dispersion parameter values (standard deviations of plume spread as a function of downwind distance or time and atmospheric stability) derived from continuous point sources. Sometimes these values are applied with subjective modifications. For example, models used for airports or highways use the same dispersion parameters as models used for elevated area or point sources.

One logical approach would involve the separate verification of each of the submodels based on specific experiments; however, expense dictates that accuracy of the overall model be examined.

There are many opinions as to how a Gaussian model that uses subjective modifications to handle the various configurations encountered should be validated, verified, or calibrated. In this discussion a specific approach for complex Gaussian models of airport scale is suggested. The data requirements for model verification include meteorology and emission data (the necessary information for model concentration calculations) and measured air quality concentrations (including background information) with which to compare the calculations.

Previous verification programs comparing short-term (1-3 hours) calculations (Koch and Thayer 1971, Rote, et al. 1973) with observations have demonstrated the difficulty in coming to specific conclusions using any one comparison technique or statistic. The scatter-diagram approach prevalent in the literature has not been particularly useful for verification because of wide scatter and low correlation between measured and calculated concentrations. The reason direct comparison of calculations to observations does not provide good results is the statistical nature of the complex Gaussian model. For instance, the Gaussian approach assumes steady-state conditions over a specific period of time, usually one hour. When modeling intermittent or moving sources such as automobils or aircraft, simplifying assumptions are necessarily made; for instance, taxiing aircraft are usually modeled as line sources considered to be continuous over periods relatively long compared to individual aircraft taxi time. In reality, there is not a continuous Gaussian plume stretched out downwind of such sources but intermittent ones that are locally distorted by variable wind speed and direction (turbulence). Data collection for such comparisons is presently accomplished by a network of monitors at fixed horizontal and vertical locations. The total number of monitors or stations is usually less than five because of monetary restraints. Considering these limitations, it is not surprising that short-term calculations and observations do not correlate well. The comparison of cumulative frequency distributions, on the other hand, has enabled some modelers to make general statements about the overall performance of their specific models.

RECOMMENDED VERIFICATION APPROACH

It is assumed that a large data base is taken over a period long enough to provide information under varying conditions of meteorology and emission modes. Assuming such a data base is available, the following procedures for model verification are proposed.

DISCUSSION OF THE DATA BASE

The data base discussion should include efforts made to provide background information and quality assurance during the actual collection of data. A discussion of the adequacy of the numbers and locations of actual air quality monitoring sites should be included, together with specific geometry relating sources and receptors to the general meteorological conditions during the data collection period.

COMPARISONS FOR ANALYSIS

A thorough verification requires that data and concentration calculations (model predictions) be compared under a number of different circumstances. Because of the conglomerate nature of the complex Gaussian model, certain meteorological conditions or receptor locations may give better or worse results compared to others in the same model application. Each monitoring location should therefore be evaluated separately in addition to overall evaluation of the model. Evaluating each monitoring location separately will give the modeler an indication of the performance of the dispersion submodel under different situations. This is important because at the present time the dispersion submodels of most Gaussian complex models are subjective in nature and not based on dispersion experiments. There is reason to believe that a great deal of the wide scatter in observed and predicted values already discussed is the result of the dispersion submodel. The airport pollution data should be stratified in the following categories:

1. High and low emission density periods.
2. Periods of the day (can include more than one hour) dependent upon emission operations and meteorology.
3. Seasons (this category is optional and depends on the nature of the data and problem).
4. Meteorological categories:

   Wind direction - Increments will depend on situation.

   Wind speed - Increments will depend on situation.

   Stability category - Pasquill categories or in some cases stable, neutral, and unstable will be sufficient.

   Mixing height - Two or three categories based on a chosen mixing height dependent upon the scale of the model application will be sufficient. For instance, in the case of airport models: mixing height below 100 m; mixing height above 100 m; and unlimited mixing.

Note that the above categories are not meant to be mutually exclusive. Only data that are above the noise level of the particular pollutant monitoring instruments used should be evaluated. Although there is a specific interest in pollutant levels approaching National Ambient Air Quality Standards, all levels should be evaluated.

CUMULATIVE FREQUENCY DISTRIBUTIONS AND ERROR LIMITS

The data should first be sorted according to the above scheme; for instance, all cases in a specific wind-direction category, all cases during the morning hours, etc. (approximately 26 separate categories). The data should then be displayed on cumulative frequency distribution diagrams, similar to the one in Figure 1, if at least 30 observations within a given category are available. If there are fewer than 30 observations, a scatter diagram of observed versus calculated concentrations should be prepared. Longer term averages -- for instance, monthly or yearly -- will inherently have fewer data points for comparisons and therefore will require scatter

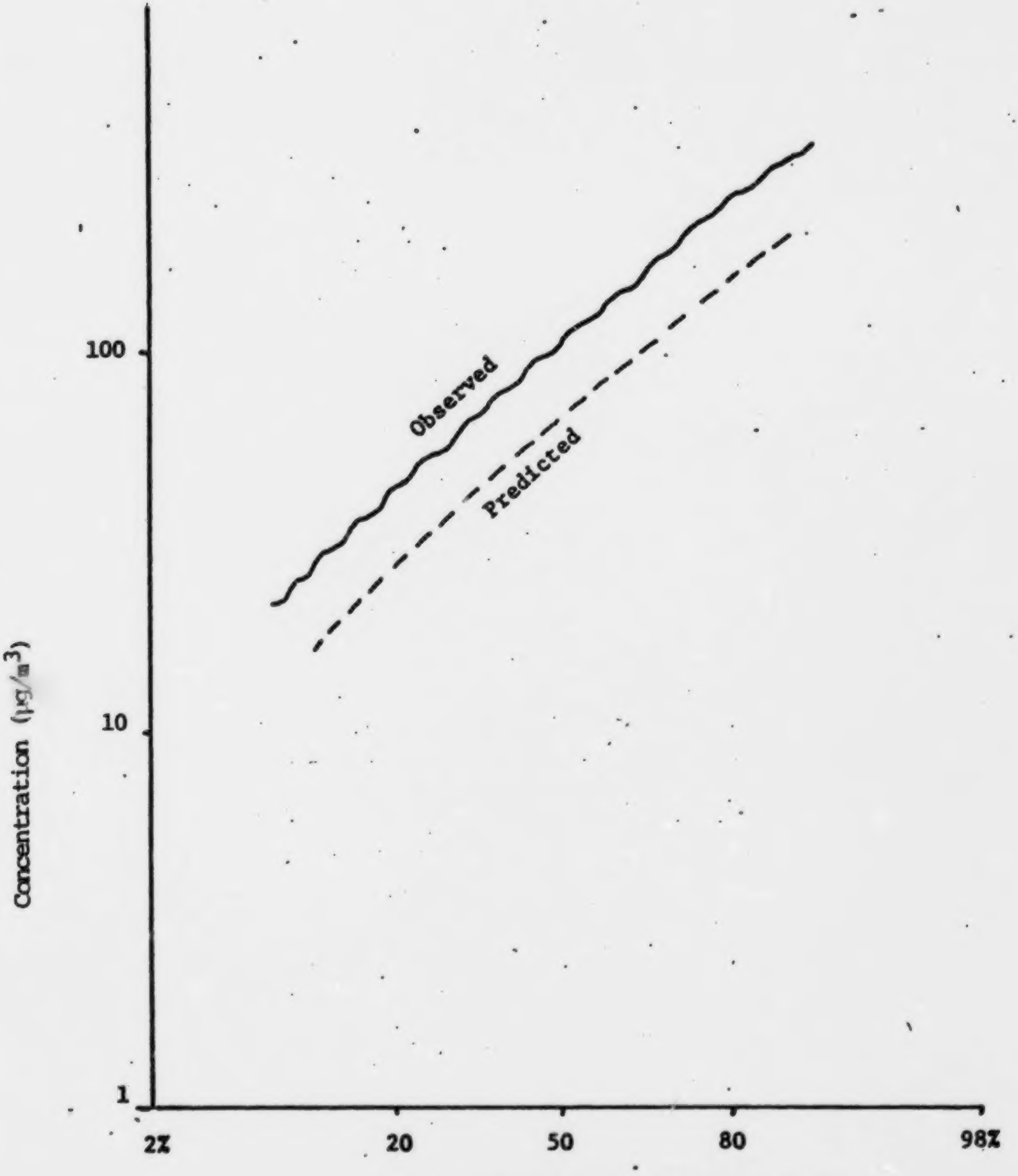

Figure 1. Cumulative frequency distribution for site #X during periods of Y wind direction.

diagrams. The use of the scatter diagram will give a qualitative feel for the performance of the model even though in some cases resultant coefficients for calibration purposes may be lacking in significance.

It is desirable to have a number measure of model performance for specific cases. A cumulative frequency distribution of the calculation error should be constructed to allow the modeler to report the percentage of trials for which his estimate was within a specific range of the observation. A similar approach was used by Koch and Thayer (1971); frequency distribution plots of absolute value of overpredictions and underpredictions similar to Figure 2 should be prepared. The approach suggested in this discussion is to subtract each observation from each corresponding model prediction. This will provide information on the distribution of overpredictions and underpredictions in addition to the overall tendency of the model to over- or underpredict in that specific category. Subtracting the cumulative percentage of overpredictions from the cumulative percentage of underprediction (see Figure 2) at a specific concentration difference will give the percent of comparisons that fall within that specific concentration error limit. The error limits and corresponding percentages can then be plotted on a frequency distribution diagram similar to Figure 3. The modeler will then be able to report that in the given situation his predictions were within $\underline{x}$ ($\mu g/m^3$) $\underline{y}$ percent of the time for that particular data category using the verification data set. It must be recognized that the percentage of error is not dispayed in the above technique; that is, the number difference between a predicted value of 2 and a measured value of 4 is the same as between that of 100 and 102 but the percent error is quite different.

PERCENT ERROR DISTRIBUTION

In order to evaluate the percentage error and make the verification results usable for all ranges of concentrations, the following procedure should be followed.

Using the same categories previously discussed, prepare frequency diagrams of the percent error, E;, as shown in Figure 4.

$$E; = \frac{xc - (\bar{x}o - \bar{x}b)}{(\bar{x}o - \bar{x}b)} *100$$

where: E; = Percent error per case

$\bar{x}c$ = Model calculation without background

$\bar{x}o$ = Observed air quality

$\bar{x}b$ = Estimate of background air quality

The display of Figure 4 will also enable the model evaluator to discuss model bias, $\bar{E}$, randomness, $\sigma_E{}^2$, and overall variance, $\sigma_T{}^2$, for each category.

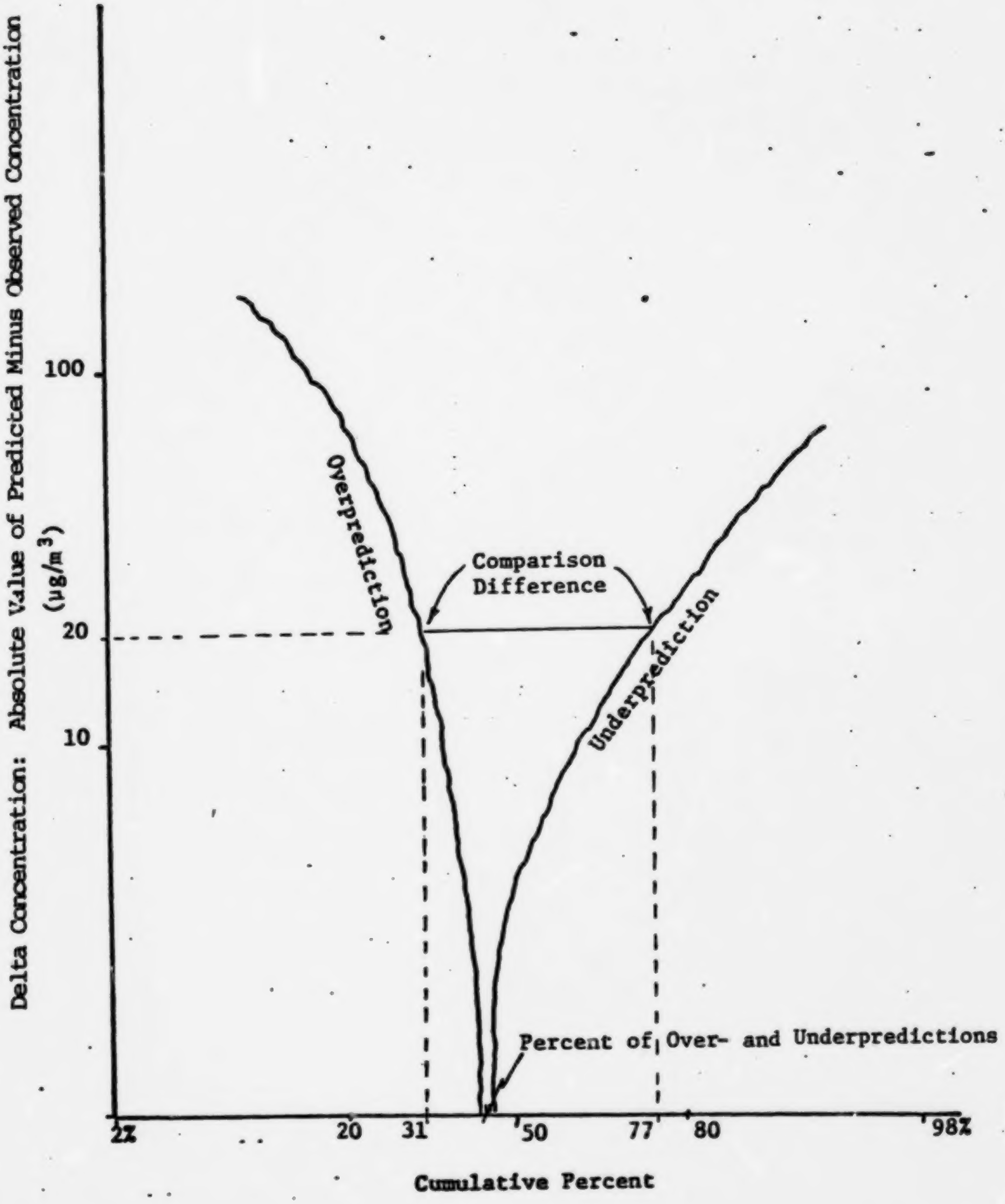

Figure 2. Delta concentration: in this example, 77-31, or 46 percent of the time, the difference between observed and predicted was within ± 20 $\mu g/m^3$.

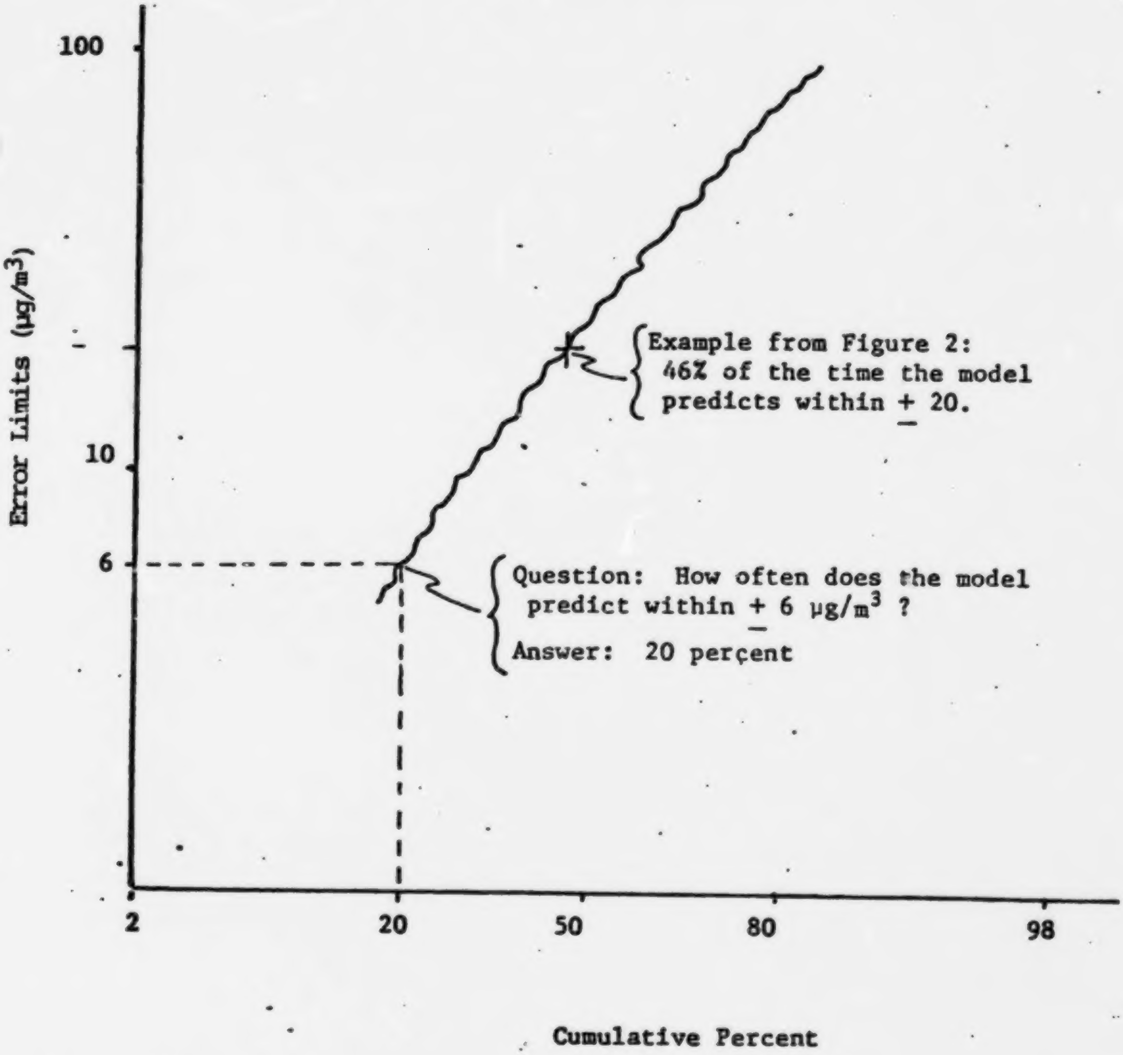

Figure 3. Error Limit Diagram.

where:

$$\bar{E} = \frac{1}{n}\sum_{i=1}^{n} E_i \quad \text{(bias)}$$

$$\sigma_E^2 = \sum_{i=1}^{n} \frac{(E_i - \bar{E})^2}{n} \quad \text{(randomness)}$$

$$\sigma_T^2 = \frac{\Sigma}{n} E_i^2 \quad \text{(overall variance)}$$

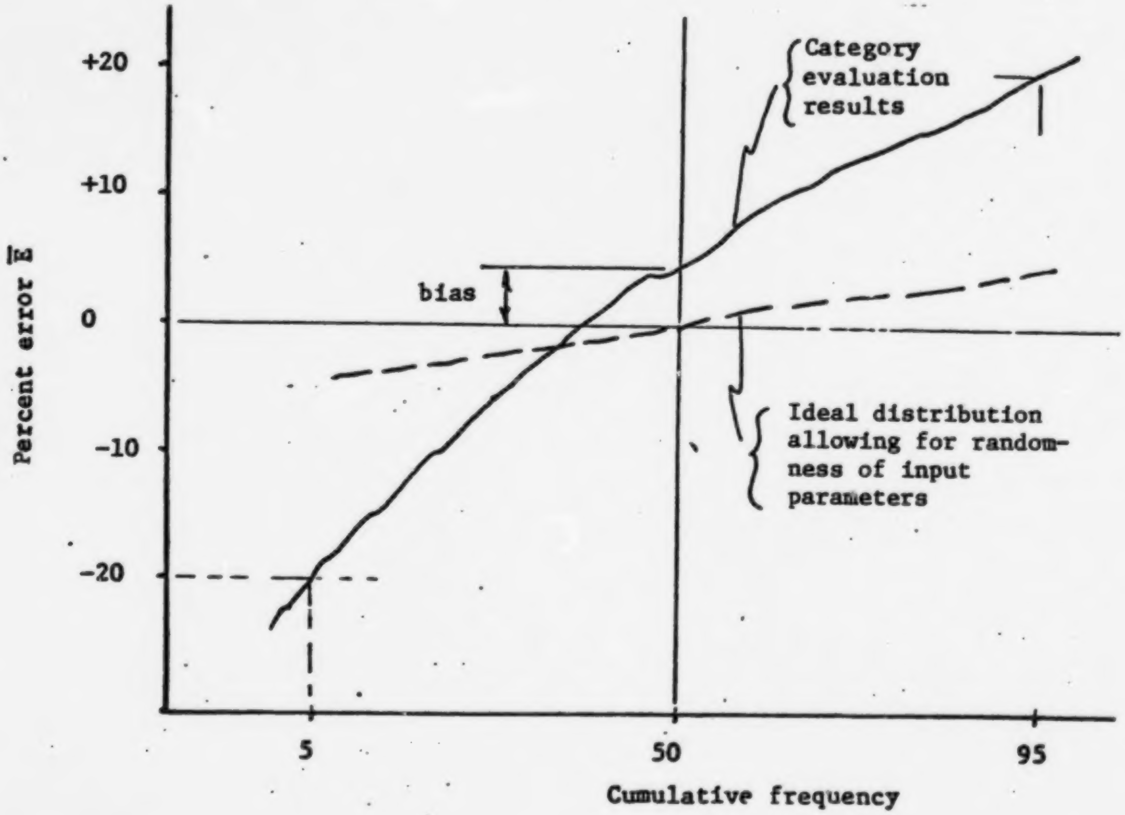

Figure 5. Percent error and cumulative frequency diagram.

EMISSION SUB-MODEL ADJUSTMENT

Because each of the inputs to the model has uncertainties expressed as a standard deviation (σ), the model output cannot be expected to match perfectly with the measured concentrations. However, if the actual variations of the input parameters are independent of each other and the input parameters are the true mean values of their distributions, then the percentage error assuming $x_b = 0$, $\bar{E} = (x_c \text{ model} - x_o \text{ observation})$, should be normally distributed with mean zero and a total standard deviation, σ_T. If the mean $\bar{E}$ is significantly different from zero, as determined by a statistical test, then the question "What is causing the error?" should be asked. Assuming that adequate quality assurance is maintained for the measured pollution concentration and meteorological data, the largest uncertainties will probably be either in the emission inventory or within the model itself.

Although in theory the measured product of the concentration, x_o, observation, and the wind velocity, $\bar{u}$, is a flux (mass/area-time) and can be used with a model to compute the emissions Q (g/sec), this inverse of the standard modeling technique is not practical. A possible technique to test the emission inventory would be to break the data sets into two significantly different meteorological conditions such as stable and unstable. If the emission inventory is in error and the model is consistent, $\bar{E}$ should show similar bias from zero for both periods.

If the $\bar{E}$ values are significantly different for both conditions the emission inventory and the model may both be in error.

Such an analysis can be used to justify modifying the emission inventory Q to set E to zero for both data sets as a whole. If this adjustment of Q is valid, then a third data set, independent of the two used as described above, can be used to determine $\bar{E}$. If $\bar{E}$ is not significantly different from zero for this new data set, then the adjusted Q value would appear to be the valid one to use for further study of the model.

MODEL VERIFICATION DISCUSSION

A subjective discussion should accompany each comparison, pointing out various aspects specific to the model and data base being used. The discussion will depend upon the interpretation of the investigator. Next, the data should be multistratified using the above single categories; for instance, one stratum may be all cases during winter morning periods with windflow from a northerly direction, atmospheric conditions stable, and low wind speeds. In this case the categories would be mutually exclusive. This data comparison should also be presented in both frequency distribution and scatter diagrams of observed versus predicted if there are more than 30 examples and scatter diagrams only if there are less than 30 examples. Each distribution or scatter diagram should be evaluated and subjectively discussed.

It is recognized that there is a great expense involved in extensive model calculations to fulfill the above requirements. Perhaps in practice models can be evaluated generally in the broad single category groups using a subset of the total data set to evaluate cumulative frequency distributions. A few of the multistratified categories should then be selected for specific model performance, preferably those with the most data. When the model is then used in a specific application and that application is in question and not previously verified, the data base would be reevaluated for the specific situation in question.

CONCLUSIONS

Upon completion of the above analysis, assuming a good air quality data base, the modeler would have a good idea of how valid his model really is. In addition, an independent model user or Environmental Impact Statement reviewer would be able to scan the verification report and obtain a quick feel of how the model performs compared to a real data set.

The recommended verification procedure discussed above does not require specific model correlation coefficients or any other number on which to determine a pass/fail grade for the model.

The final decision as to whether the model is valid or not, therefore, will not depend upon any specific performance limitation; however, it will depend upon the user's ability to support the use of the model in any instance based on the verification analysis.

ACKNOWLEDGEMENT

This discussion was prepared by Karl Zeller, NOAA meteorologist on assignment to EPA, Las Vegas, Nevada. Thanks are due Dr. David Mage, EPA, Las Vegas, Nevada, for helpful suggestions used in the preparation of this discussion.

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PRELIMINARY AIR QUALITY ANALYSIS (1975)

The ambient air analysis study (Section 2), conducted as a preliminary guide to the development of the WAFB monitoring operations, provided qualitative information on plume rise and initial exhaust plume pollutant concentration as a function of distance. The static jet portion of this study was conducted during idle and power engine modes while a helicopter made downwind passes at altitudes between 3.1 m and 42.7 m AGL.

Relative concentrations based on the averages from all traverses of the helicopter were used to determine effective plume rise, useful for vertical dispersion verification. From these averages, jet exhaust plumes were located at 7 m AGL, 50 m downwind; 20 m AGL, 100 m downwind; 20 m AGL, 150 m downwind; and 21 m AGL, 200 m downwind. The full report is included in its unpublished form.

AIR QUALITY DATA COLLECTED BY EPA EMSL-LV AT WILLIAMS AFB DURING THE SHORT TERM APRIL 1975 AIRPORT STUDY

U.S. Environmental Protection Agency
Office of Research and Development
Environmental Monitoring Systems Laboratory
Las Vegas, Nevada 89114

Karl Zeller and Monty Price

INTRODUCTION

The EPA, the Air Force, and Argonne National Laboratory (ANL) have an interest in determining the influence of airport activities on the surrounding air quality. Computer models have been developed to assess this influence. In order to prove the usefulness of these models, they must be validated using real data. Efforts to gather airport air quality data in the past (previous efforts include studies of Los Angeles, O'Hare, National Airport, and Atlanta) have not provided data useful for this function. Therefore, the Air Force and the EPA have entered into an interagency agreement (EPA-IAG-R5-0788) that provides for a long-term study to collect data with which to make statistical validations of the models.

Prior to the long-term study, it was necessary to attempt to delineate pollutant transport qualitatively to determine the necessary numbers and locations of long-term air quality monitoring stations.

To accomplish the preliminary study, (referred to by the Air Force as the "Ambient Air Analysis Survey at Selected Locations" study), the Air Force, the EPA, and ANL joined efforts during the period April 1-18, 1975. The preliminary study was divided into three experiments: a grab sampling effort at selected locations around the airport (primary responsibility of ANL); a single-jet impact study (primary responsibility of the EPA with ANL bag sampling support); an effort to determine the adequacy of certain ambient air quality instrumentation considered for possible use in the long-term study (responsibility of the EPA) (this effort was continued through June 1975).

The purpose of this report is to present data collected by the EPA during the short-term April 1975 study at Williams AFB. The data presented here were taken at an air monitoring station set up to accomplish the third objective above, and by the EPA H-34 air quality monitoring helicopter during the single-jet study. This report presents only the EPA data. No conclusions are drawn. This report should be used in conjunction with ANL's report in order to obtain a complete record of the experiment.

AIR MONITORING STATION

An Air Stream trailer equipped with monitoring instruments was used by the EPA to monitor ambient air at Williams AFB. The trailer was located in the southeast portion of the base near the southeast end of Runway Number Three, 150 feet from Antenna Station Number 1101 and approximately 500 feet from the nearest runway (Figure 1). A REM model 612B chemiluminescence ozone analyzer was used to measure ozone. A Monitor Labs chemiluminescent nitrogen oxide analyzer Model 8440 was used to determine nitric oxide and nitrogen dioxide. The NO/NO_2 instrument failed early in the experiment; therefore no NO/NO_2 data are reported. A Beckman Model 6800 gas chromatograph was used to measure total hydrocarbons, methane, and carbon monoxide. All data were recorded on strip charts. Ambient air was drawn into the trailer through a covered sampling port in the ceiling of the trailer. A 1 1/2-inch-diameter sampling manifold made of Teflon tubes joined with stainless steel tubing was connected to the sampling port. A pump was used to draw air through the manifold at the rate of 10 cubic feet per minute. One-quarter-inch Teflon sampling lines connected the instruments to the stainless steel portion of the sampling manifold. A Staplex TFIA high-volume sampler was used to collect particulate matter. The sampler was enclosed in a wooden frame located 100 feet from the trailer. A second Beckman 6800 gas chromatograph was located in Room 8 of Building 320. This instrument sampled room air and was used to analyze bags collected during the special static-jet study. The data from this instrument were recorded on strip charts but not reduced.

Calibration standards used in the study were as follows: The carbon monoxide standard was prepared by the Matheson Gas Company. The concentration (approximately 2.8 ppm in air) was determined by comparison with an NBS-prepared carbon monoxide standard. The mixture of propane, methane, and carbon monoxide used as a standard was prepared by Matheson Gas Company. The propane and methane concentrations were determined by that company using gas chromatography. The carbon monoxide concentration was determined by comparison to standard. The ozone calibration concentration was determined by measuring the calibration stream with a Dasibi ozone analyzer that had been calibrated using the KI method defined in the Federal Register, Volume 36, number 84, April 30, 1971.

The Beckman 6800 calibration was done by passing calibration gas through the instrument at 20 ml min while in the calibration mode. The instrument was spanned so that 8.6 ppm methane represented 86 percent of scale, 8.6 ppm methane and 1.8 ppm propane (14.0 ppm carbon) represented 70 percent of total hydrocarbon scale, and 2.8 ppm carbon monoxide represented 28 percent of scale. The REM ozone analyzer was calibrated by zeroing it with filtered air giving a 0.000 ppm ozone reading on the Dasibi ozone analyzer, then supplying ozone produced by a Monitor Labs Model 8440 ozone generator at concentrations of 0.50 to 0.80 ppm. The REM was set at the 0.0 to 0.2 ppm range and the recorder scale was 0.0 to 0.1 ppm.

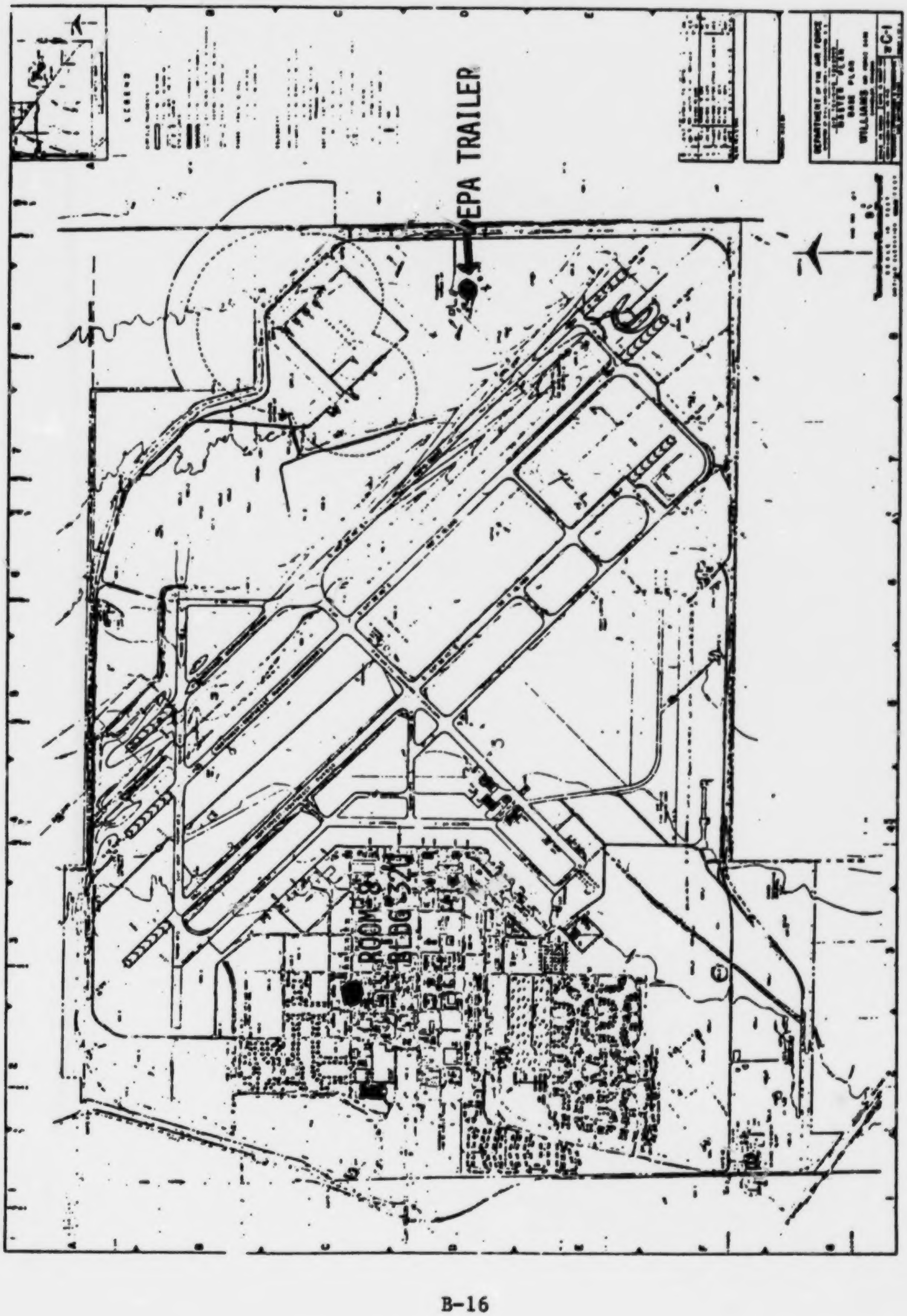

EPA TRAILER
ROOM 8
BLDG 324

Figure 1. Map of Williams AFB showing location of EPA trailer.

The ambient air was monitored at the EPA trailer location continuously from April 9 to June 18, except for minor interruption for maintenance and calibrations. The ozone instrument sampled intermittently from April 9 to April 17. The Beckman 6800 sampled instantaneously once every five minutes from a continuous sampling stream of 5 liters/min. In order to get a representative sample from the Beckman 6800, a 5 gallon (18.9 liters) averaging bottle was placed between the sample manifold and the instrument. The characteristics of the averaging bottle (volume/flow = 3.8 sec.) would cause a 6.1 percent error in the reading if a one-minute pollution step change of 10 times normal concentration were to pass through the sample inlet. The data for April 9-17 are given in Table I. The data for April 17 to June 18 are given in the appendix.

The high-volume filters were changed every day at approximately 4:00 p.m. The flow rates at the beginning and ending of the sampling period were measured. The filter paper was dried and weighed before and after sampling by the Clark County Air Pollution Lab. The results are listed in Table II.

There are many causes of error that plague the quality of collected air quality data. The most common are instrument drift, changes in environmental conditions, and errors resulting from sample handling. The problems caused by changes in environmental conditions, such as changes in temperature and pressure could be significant if instruments were not housed in an enclosed environment. The sampling temperature and pressures of the EPA trailer were not recorded, and the data herein are not corrected for the slight variations in these parameters. However, environmental chamber tests show these errors to be small. The ozone drift was sometimes as much as .010 ppm in the negative direction. Values below minium detectable concentrations are recorded as .000 in Table I. Taking into consideration all possible errors, the ozone values can be reasonably considered to be conservative with ± .02 ppm. The total maximum hydrocarbon span drift was 4 percent of fullscale; the maximum methane span drift was 2 percent of fullscale; the maximum carbon monoxide drift was 4 percent of fullscale. The zero drift of the Beckman 6800 was not tested because the instrument has an auto - zero. The Beckman 6800 was calibrated weekly and checked daily during the period April 18 through June 24, 1975.

During the first two weeks in April, an additional check of instrument performance was performed. Bag samples of CO were intercompared using the ANL NDIR and the EPA Beckman 6800. The results are shown in Table III.

In order to use the data presented herein for evaluating the possible success of a longer study, it must be pointed out that the normal background levels of these pollutants must be subtracted from the presented measurements in order to assess the contribution of local sources. Approximate worldwide background levels are: methane, 1.4 ppm; total hydrocarbon (except methane) 0.02 ppm; carbon monoxide, 0.25 ppm; nitric oxide, 0.005 ppm; and nitrogen dioxide, 0.001 ppm.

TABLE I: AVERAGE VALUES OF NO, NO_x, O_3, TOTAL HYDROCARBON, METHANE, AND CO CONCENTRATIONS MEASURED BY THE EPA TRAILER AT WILLIAMS AFB - APRIL 10-17, 1975

		Concentration (ppm)				
Date	Time	O_3	THC	Me	CO	WD/DS
4/9/75	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000	.03				
	1000-1100	.02				
	1100-1200	.03				
	1200-1300	.03				
	1300-1400	.05				
	1400-1500	.04				
	1500-1600	.03				
	1600-1700	.03				
	1700-1800	.02				
	1800-1900	.02				
	1900-2000	.01				
	2000-2100	.01				
	2100-2200	.01				
	2200-2300	.01				
	2300-2400	.01				
4/10/75	0000-0100	.01				
	0100-0200	.00				
	0200-0300	.00				
	0300-0400	.00				
	0400-0500	.01				
	0500-0600	.01				
	0600-0700	.02				
	0700-0800	.03				
	0800-0900	.05				
	0900-1000	.04	2.04	1.52	.52	13404
	1000-1100	.03	1.78	1.58	.42	
	1100-1200	.03	1.76	1.57	.43	
	1200-1300	.03	1.76	1.54	.42	
	1300-1400	.03	1.76	1.52	.40	15805
	1400-1500	.03	1.66	1.51	.41	19206
	1500-1600	.04	1.64	1.51	.40	26706
	1600-1700		1.68	1.52	.41	
	1700-1800		2.52	1.50	.36	
	1800-1900		2.42	1.50	.36	
	1900-2000		2.28	1.52	.44	
	2000-2100		2.60	1.56	.46	
	2100-2200		3.08	1.64	.49	
	2200-2300		2.90	1.54	.52	
	2300-2400		2.44	1.54	.48	

TABLE I (continued)

Date	Time	O_3	THC	Me	CO	WD/WS
4/11/75	0000-0100		2.48	1.52	.42	
	0100-0200		2.70	1.53	.43	
	0200-0300		2.98	1.53	.46	
	0300-0400		2.84	1.50	.41	
	0400-0500		2.90	1.51	.36	
	0500-0600		2.88	1.56	.38	
	0600-0700		2.80	1.53	.41	
	0700-0800		2.40	1.50	.38	
	0800-0900		1.68	1.50	.46	
	0900-1000		1.68	1.52	.46	
	1000-1100		1.92	1.49	.46	
	1100-1200		2.00	1.50	.41	
	1200-1300		2.00	1.50	.40	
	1300-1400		2.00	1.50	.38	11604
	1400-1500		1.60	1.49	.39	14805
	1500-1600		1.48	1.49	.40	17704
	1600-1700		1.52	1.50	.42	
	1700-1800		2.70	1.51	.43	
	1800-1900	.004	4.14	1.52	.72	
	1900-2000	.008	5.50	1.80	.74	
	2000-2100	.010	5.90	1.62	.56	
	2100-2200	.020	6.10	1.56	.52	
	2200-2300	.014	6.00	1.56	.56	
	2300-2400	.004	7.10	1.65	.54	
4/12/75	0000-0100	.010	6.84	1/70	.71	
	0100-0200	.006	6.02	1.70	.69	
	0200-0300	.008	6.44	1.68	.68	
	0300-0400	.010	6.94	1.58	.56	
	0400-0500	.010	7.02	1.68	.58	
	0500-0600	.006	7.30	1.63	.58	
	0600-0700	.004	8.30	1.72	.63	
	0700-0800	.012	7.10	1.62	.57	
	0800-0900	.012	6.84	1.64	.59	
	0900-1000	.032	7.64	1.62	.63	
	1000-1100	.032	7.56	1.56	.49	
	1100-1200	.036	5.50	1.49	.46	
	1200-1300	.038				
	1300-1400	.030				
	1400-1500	.030	1.66	1.51	.43	
	1500-1600	.032	1.64	1.50	.44	
	1600-1700	.030	1.64	1.50	.42	
	1700-1800	.026	1.70	1.51	.50	
	1800-1900	.024	1.70	1.51	.52	
	1900-2000	.024	1.80	1.52	.51	
	2000-2100	.022	1.80	1.50	.46	
	2100-2200	.016	1.80	1.50	.42	
	2200-2300	.014	1.82	1.49	.44	
	2300-2400	.006	1.88	1.48	.42	

TABLE I (continued)

Date	Time	O_3	THC	Me	CO	WD/WS
4/13/75	0000-0100	.006	1.98	1.51	.42	
	0100-0200	.010	1.98	1.50	.43	
	0200-0300	.006	1.96	1.49	.42	
	0300-0400	.000	2.00	1.50	.41	
	0400-0500	.002	2.00	1.49	.41	
	0500-0600	.002	2.00	1.50	.40	
	0600-0700	.004	1.96	1.49	.41	
	0700-0800	.006	1.96	1.50	.41	
	0800-0900	.010	1.96	1.51	.43	
	0900-1000	.012	1.84	1.52	.42	
	1000-1100	.020	1.92	1.51	.46	
	1100-1200		1.80	1.52	.43	
	1200-1300		2.86	1.51	.43	
	1300-1400	.006	2.44	1.50	.38	
	1400-1500	.010	2.40	1.52	.42	
	1500-1600	.010	4.00	1.50	.43	
	1600-1700	.008	4.08	1.50	.42	
	1700-1800	.008	3.20	1.52	.42	
	1800-1900	.008	4.36	1.51	.48	
	1900-2000	.008	1.90	1.52	.48	
	2000-2100	.000	3.44	1.52	.51	
	2100-2200	.000	6.20	2.11	.68	
	2200-2300	.000	6.30	1.60	.46	
	2300-2400	.000	6.04	1.60	.44	
4/14/75	0000-0100	.000	5.88	1.52	.52	
	0100-0200	.000	5.04	1.54	.46	
	0200-0300	.000	5.00	1.60	.47	
	0300-0400	.000	4.70	1.53	.43	
	0400-0500	.000	4.60	1.52	.42	
	0500-0600	.000	4.80	1.52	.43	
	0600-0700	.000	5.16	1.53	.42	
	0700-0800	.000	5.32	1.52	.44	
	0800-0900	.000	4.56	1.51	.42	
	0900-1000	.002	4.04	1.52	.46	
	1000-1100	.010	4.26	1.52	.42	
	1100-1200	.016	3.70	1.51	.40	
	1200-1300	.020	4.42	1.52	.41	
	1300-1400	.022	3.42	1.50	.43	
	1400-1500	.022	3.64	1.50	.41	21004
	1500-1600	.020				
	1530-1600		2.48	1.49	.38	22405
	1600-1700	.018	2.80	1.49	.34	23005
	1700-1800	.016	3.12	1.42	.34	23804
	1800-1900	.004	3.68	1.46	.38	
	1900-2000	.000	4.88	1.48	.36	
	2000-2100	.000	5.84	1.51	.36	
	2100-2200	.000	7.04	1.52	.43	
	2200-2300	.000	8.40	1.52	.42	
	2300-2400	.000	8.62	1.54	.44	

TABLE I (continued)

Date	Time	O_3	THC	Me	CO	WD/WS
4/15/75	0000-0100	.000	7.06	1.52	.46	
	0100-0200	.000	7.40	1.50	.42	
	0200-0300	.000	6.04	1.49	.40	
	0300-0400	.000	5.92	1.46	.34	
	0400-0500	.000	6.00	1.48	.36	
	0500-0600	.000	6.32	1.46	.33	
	0600-0700	.000	6.60	1.49	.38	
	0700-0800	.000	7.04	1.47	.43	
	0800-0900	.000	6.84	1.52	.46	
	0900-1000	.006	6.52	1.48	.41	
	1000-1100	.016	6.16	1.50	.46	
	1100-1200	.018	5.80	1.48	.42	
	1200-1300	.020	5.28	1.47	.37	15902
	1300-1400	.020	5.20	1.48	.38	14902
	1400-1500	.024	4.30	1.44	.36	22802
	1500-1600	.024	4.22	1.45	.35	18402
	1600-1700		3.44	1.46	.34	16502
	1700-1800	.064	4.10	1.42	.36	14301
	1800-1900	.062	5.72	1.50	.42	
	1900-2000	.054	6.00	1.50	.47	
	2000-2100	.040	7.12	1.55	.56	
	2100-2200	.032	8.00	1.66	.68	
	2200-2300	.024	7.88	1.62	.72	
	2300-2400	.028	8.00	1.61	.64	
4/16/75	0000-0100	.032	8.56	1.63	.53	
	0100-0200	.034	9.00	1.59	.47	
	0200-0300	.032	8.88	1.56	.43	
	0300-0400	.030	7.36	1.55	.45	
	0400-0500	.038	5.36	1.50	.38	
	0500-0600	.032	5.10	1.49	.42	
	0600-0700	.030	5.72	1.57	.41	
	0700-0800	.036	5.24	1.51	.43	
	0800-0900	.048	4.88	1.50	.42	
	0900-1000	.056	5.20	1.51	.41	
	1000-1100	.058	4.56	1.48	.40	
	1100-1200	.066	4.26	1.47	.36	
	1200-1300	.064	2.00	1.41	.36	
	1300-1400	.046	2.62	1.42	.41	21903
	1400-1500	.042	3.00	1.44	.40	
	1500-1600	.046	3.36	1.48	.42	25405
	1600-1700	.046	3.20	1.42	.40	28404
	1700-1800	.040	4.08	1.51	.48	28404
	1800-1900	.028	5.00	1.50	.41	
	1900-2000	.014	6.04	1.53	.62	
	2000-2100	.014	7.20	1.53	.56	
	2100-2200	.012	6.50	1.42	.43	
	2200-2300	.026	5.20	1.47	.46	
	2300-2400	.012	4.62	1.43	.48	

TABLE I (continued)

Date	Time	O_3	THC	Me	CO	WD/WS
4/17/75	0000-0100	.016	4.64	1.44	.42	
	0100-0200	.012	4.10	1.42	.38	
	0200-0300	.010	4.02	1.46	.37	
	0300-0400	.014	4.24	1.45	.39	
	0400-0500	.018	4.30	1.49	.43	
	0500-0600	.022	4.20	1.49	.53	
	0600-0700	.024	3.24	1.48	.48	
	0700-0800	.032	2.70	1.47	.43	
	0800-0900	.036	2.46	1.48	.40	
	0900-1000	.038	2.50	1.50	.39	
	1000-1100	.038	2.50	1.49	.40	
	1100-1200	.046	2.80	1.48	.41	
	1200-1300	.040	2.64	1.48	.40	
	1300-1400	.040				
	1400-1500	.050				
	1500-1600	.052				
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					

TABLE II PARTICULATE MATTER COLLECTED WITH A HIGH VOLUME SAMPLER AT WILLIAMS AFB, APRIL 11-17, 1975.

( ) indicate approximations because flow rate was not recorded.

Time/Date	Sample-flow rate (cfm) start	stop	Sample weight	Concentration ($\mu g/m^3$)
6PM 4/8/75 - 4PM 4/9/75			.0418 gm	(45)
4PM 4/9/75 - 4PM 4/10/75			.0607 gm	(60)
4PM 4/10/75 - 4PM 4/11/75			.0306 gm	(30)
4PM 4/11/75 - 4PM 4/14/75	27	24	.2055 gm	66
4PM 4/14/75 - 4PM 4/15/75	26	24	.0989 gm	97
4PM 4/15/75 - 4PM 4/16/75	24	23	.1276 gm	133
4PM 4/16/75 - 4PM 4/17/75	29.5	28	.1951 gm	166

SINGLE-JET STUDY

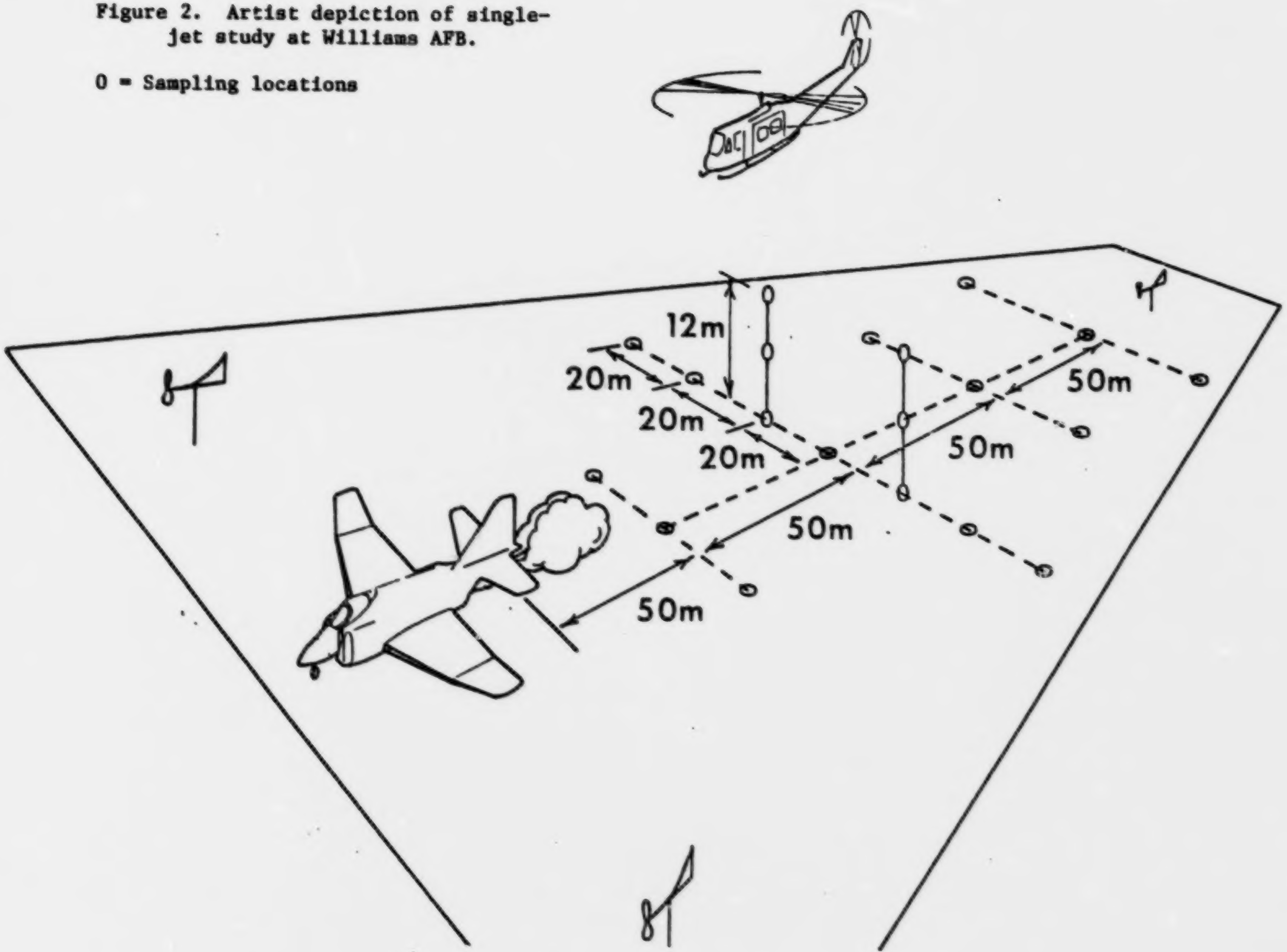
The objective of the single-jet study was to document the air quality contribution of a single, static jet during idle and power modes.

TABLE III. COMPARISON OF CO CROSS-CALIBRATION STANDARDS BETWEEN THE ANL NDIR AND THE EPA BECKMAN 6800

Date	Sample	CO Concentration (ppm) NDIR	6800
4/05/75	#2 unknown		9.2
4/11/75	Argonne sample		7.6
4/15/75	#5 1-2 p.m.	0.6	0.73
4/15/75	#7 1-2 p.m.	0.9	0.82
4/15/75	#7 2-3 p.m.	0.7	0.92
4/15/75	#7 3-4 p.m.	1.0	0.84
4/15/75	#13 3-4 p.m.	1.1	0.91
4/15/75	#5 2-3 p.m.	0.8	0.72

The experiment was carried out on Saturday, April 5, 1975. The sampling consisted of data from an array of ground stations at which bag samples and data from an air quality instrumented helicopter were collected. A visual concept of the experiment is presented in Figure 2.

Samples were taken at the 13 ground locations. They were first analyzed by ANL for carbon monoxide with a Beckman NDIR analyzer. The sample bags were then analyzed for total hydrocarbon, methane, and carbon monoxide with the EPA Beckman 6800 located in Room 8. The sampling procedure for the Beckman 6800 was to operate the instrument in the calibration mode, connect the bag to the calibration input port, squeeze the bag so that 100 ml of sample flushed the sampling system during the minute before sampling, and then flush the sample through the sampling system at 20 ml per minute until the sampling cycle was completed. The results are listed in Table IV. The error caused by squeezing the sample from the bag into the Beckman 6800 was tested by comparing the readings of the standard samples dispensed from a bag and a cylinder. The results showed that the bag-sample readings were: total hydrocarbon, no change; methane, 5 percent low; and carbon monoxide, 7 percent low.



12m
20m
20m
20m
50m
50m
50m
50m

Figure 2. Artist depiction of single-jet study at Williams AFB.

0 = Sampling locations

TABLE IV. THE TOTAL HYDROCARBON, METHANE, AND CARBON MONOXIDE ANALYSIS OF BAG SAMPLES COLLECTED DURING THE AIRCRAFT TEST AT WILLIAMS AFB, April 5, 1975. This analysis was done on a Beckman 6800 chromatograph.

SAMPLE		Concentration (ppm)			
Run	Station	THC	Me	CO	Comments
1	1				no sample
	2				no sample
	3				no sample
	4				no sample
	5				no sample
	6				empty
	7	2.86	1.47	1.60	
	8	2.86	1.41	1.00	
	9	3.58	1.41	.50	
	10				empty
	11				empty
	12				bag broke
	13				empty
2	1	4.37	1.36	1.61	
	2				bag leaked
	3				bag leaked
	4	3.09	1.36	3.33	
	5	3.84	1.40	7.45	
	6				empty
	7	3.74	1.41	2.00	
	8	3.15	1.36	1.70	
	9				leaked
	10	4.05	1.38	2.18	
	11				empty
	12	4.09	1.36	1.38	
	13				empty
3	1				no sample
	2	4.82	2.47	>10	CO off scale
	3	3.62	1.32	4.46	
	3	3.62	1.32	4.46	repeat
	4				no sample
	5	3.94	1.33	1.96	LT base
	5				LT 25 ft. - leaked
	5	3.35	1.36	3.22	LT 40 ft.
	6	3.47	1.37	1.30	RT base
	6	3.25	1.39	.40	RT 25 ft.
	6	3.23	1.39	.70	RT 40 ft.
	7	3.15	1.40	1.78	
	8				no sample
	9				no sample
	10				no sample
	11				no sample
	12	4.07	1.37	1.49	
	13	4.08	1.32	1.51	

TABLE IV. (continued)

SAMPLE		Concentration (ppm)			
Run	Station	THC	Me	CO	Comments
4	1	5.91	1.31	2.08	
	2	7.46	1.37	10+	CO off scale
	3	5.15	1.37	10+	CO off scale
	3	5.17	1.37	14.0	Repeat, CO on 10+ scale
	4	5.27	1.34	5.50	
	5	5.33	1.36	7.58	LT base
	5				LT 25 ft- no sample
	5				LT 40 ft. - no sample
	6	5.13	1.31	3.20	RT base
	6	10.42	1.29	.53	RT 25 ft.
	6	4.35	1.30	.50	RT 40 ft.
	7	5.31	1.36	4.83	
	8	11.85	1.37	4.62	
	9	7.28	1.31	5.10	
	10	5.74	1.27	8.23	
	11	5.27	1.26	2.26	
	12				no sample
	13				no sample
5	1	4.17	1.34	1.85	
	2				empty
	3	5.97	1.38	6.68	
	4	7.23	1.36	2.47	
	5	5.31	1.36	2.23	LT base
	5				LT 25 ft. - no sample
	5	3.52	1.35	1.75	LT 40 ft.
	6				RT base - no sample
	6				RT 25 ft. - no sample
	6				RT 40 ft. - no sample
	7				no sample
	8				no sample
	9				no sample
	10	4.70	1.40	1.68	
	11	4.84	1.31	1.70	
	12				no sample
	13				no sample
6	1	3.52	1.37	1.89	
	2				empty
	3	3.92	1.34	2.94	
	4	5.99	1.36	1.80	
	5	3.33	1.37	1.92	LT base
	5				LT 25 ft. - no sample
	5				LT 40 ft. - no sample
	6	3.82	1.38	2.41	RT base
	6	5.33	1.33	1.02	RT-25 ft.
	6				RT 40 ft. - empty
	7				no sample

The EMSL-LV H-34 helicopter (designated RAPS II) outfitted with various air monitoring instruments made three flights in support of the ground-based single-jet study. Its mission was to define the vertical distribution of pollutant and pollutant related parameters. The first of these flights was aborted because of power failures. The next two flights consisted of two missions each, delineated by the power settings of the T-38 used in the study.

Instrumentation on board RAPS II consisted of a REM ozone monitor, Monitor Labs NO/NO_x monitor, Beckman CO analyzer, Meloy SO_2 analyzer, MRI nephelometer, Cambridge temperature and dewpoint sensors, pressure altimeter, and air speed indicator.

The positional equipment, DME's and VOR, normally used on RAPS II in conjunction with the air pollution instrumentation, were not used because of the confined area of the testing site. Location was identified by keying a systematic series of numbers based on ground locations into the data system by means of thumbwheel switches. Altitude was logged in from the radio altimeter; ground distance from the T-38 was entered according to the siting of ground markers. Also entered was the type of test and the approximate time spent in the plume (i.e., cross plume or down plume). All data was recorded on a Monitor Labs data system Model 7200 and on magnetic tape. Simultaneously, strip-chart recordings were made of CO, NO_x, and temperature.

During the entire testing period, no evidence of SO_2 was recorded -- that is, concentration values remained at the zero level during this time. Ozone was measured in the 35-55 ppb (v/v) range and did not appear to fluctuate significantly on passing in and out of the jet plume. Table V is a summary of the peak airborne pollutant data per pass. These are the raw data. No corrections have been made for temperature and pressure effects (on the pollutant and on the instruments) nor have corrections been implemented regarding lag and response times of the instruments or helicopter system as a whole.

Because of a known severe temperature effect on the Beckman CO analyzer, coupled with significant changes in cabin temperature, it is believed that most of the first AM CO data is invalid since the CO analyzer was drifting to adapt to cabin temperature. The later CO data was stable.

Examinations of the pollutant concentration measured by the helicopter show an impact of the jet plume well above the normal height for measuring air quality. For instance, the jet plume during the first afternoon test was detected at 70 feet AGL at 200 m downwind.

DISCUSSION OF GROUND DATA

It is interesting to note that the total hydrocarbon (THC) results were extremely high during the period of the short term study (April 9-17). The values of THC increased significantly the evening of April 11 and April 13 through April 17. The highest value observed was 9.0 ppm at 1:00 a.m. April 16, 1975. Throughout the rest of the sampling period, the THC levels were

TABLE V. HELICOPTER DATA COLLECTED DURING THE SINGLE-JET STUDY OF 5 APRIL AT WILLIAMS AFB

Test #	Altitude (feet AGL)	Downwind Distance from Exhaust (meters)	NO (ppm)	NOx (ppm)	Bscat ($10^{-4}m^{-1}$)	CO (ppm)	Temperature °C Inside	Temperature °C Outside
1st AM	25	200	0.002	0.008	0.4		21.2	20.5
	70	150	0.004	0.013	0.6		21.4	20.0
	100	150	0.000	0.011	0.3		21.0	20.0
	140	150	0.003	0.010	0.3		20.9	20.1
	120	100	0.004	0.011	0.3		20.5	20.0
	70	100	0.001	0.013	0.3		20.6	20.0
	30	100	0.001	0.010	0.3		21.3	20.1
	30	50	0.002	0.011	0.3		20.6	20.1
	15	50	0.004	0.021	1.2		21.6	20.4
	15	200	0.002	0.011	0.3		21.7	21.0
	30	**	0.003	0.009	0.3		20.9	20.4
	50	50	0.000	0.008	0.3		20.9	20.8
	15	50	0.001	0.021	1.8		22.6	21.7
	110	100	0.000	0.006	0.3		21.4	20.6
	75	100	0.002	0.013	0.3		20.6	20.4
	25	100	0.004	0.017	0.4		21.4	21.2
	110	150	0.003	0.011	0.4		21.3	20.4
	70	150	0.000	0.017	0.4		21.3	20.8
	40	150	0.002	0.012	0.3		21.7	21.2
	20	150	0.001	0.005	0.4		22.0	21.0
	40	**	0.003	0.008	0.5		22.1	21.4
2nd AM	50	200	0.001	0.010	0.3	1.1	26.1	26.0
	10	200	0.003	0.008	0.2	1.4	26.4	26.2
	90	150	0.000	0.008	0.3	1.0	26.1	26.0
	70	150	0.000	0.005	0.3	1.0	26.5	25.8
	40	150	0.003	0.011	0.3	1.1	26.5	26.0
	10	150	0.001	0.006	2.4	1.7	27.0	26.2
	100	100	0.000	0.005	0.4	1.8	26.5	26.1
	70	100	0.000	0.006	0.3	1.3	26.9	26.5
	40	100	0.001	0.005	0.3	1.2	27.0	26.8
	20	100	0.000	0.008	0.4	1.5	26.5	26.2
	50	50	0.001	0.009	0.3	1.2	27.0	26.4
	30	50	0.000	0.006	0.5	2.3	26.6	26.4
	10	50	0.005	0.013	0.3	2.9	26.8	26.1*
	50	***	0.000	0.005	0.3	1.3	26.9	26.5*
	30	***	0.001	0.006	0.3	1.4	22.9	22.2*
	50	**	0.005	0.017	0.3	3.0	23.4	22.0*

* The jet engine of the T-38 was cut off prior to these four passes.
** Parallel to exhaust
*** Background

TABLE V. (continued)

Test #	Altitude (feet AGL)	Downwind Distance from Exhaust (meters)	NO (ppm)	NOx (ppm)	Bscat ($10^{-4}m^{-1}$)	CO (ppm)	Temperature °C Inside	Temperature °C Outside
1st PM	100	200	0.000	0.006	0.3	1.1	26.5	25.3
	70	200	0.001	0.013	0.6	1.3	26.1	24.9
	50	200	0.000	0.007	0.7	1.2	25.7	24.9
	30	200	0.000	0.005	0.2	0.9	25.7	25.3
	80	150	0.000	0.004	0.3	0.9	25.8	25.6
	50	150	0.000	0.009	0.5	0.9	26.2	25.6
	25	150	0.000	0.010	0.5	1.1	27.0	26.2
	80	100	0.000	0.010	0.3	1.1	26.5	25.8
	50	100	0.000	0.008	0.6	0.9	26.1	25.6
	25	100	0.000	0.002	0.3	1.0	26.6	26.4
	40	50	0.000	0.002	0.3	0.7	26.9	26.1
	30	50	0.000	0.004	0.4	0.6	26.2	25.7
	15	50	0.000	0.014	1.1	1.3	26.8	26.2
	35	***	0.000	0.000	0.3	0.4	27.3	26.0
	20	**	0.000	0.003	0.3	1.3	26.4	25.6
2nd PM	90	200	0.000	0.007	0.2	1.1	26.1	26.0
	70	200	0.000	0.007	0.3	0.8	26.4	26.2
	40	200	0.001	0.003	0.3	0.7	26.1	26.0
	80	150	0.000	0.006	0.2	0.8	26.5	25.8
	50	150	0.001	0.004	0.3	0.5	26.5	26.0
	30	150	0.000	0.002	0.2	0.8	27.0	26.2
	80	100	0.000	0.004	0.3	0.7	26.5	26.1
	50	100	0.000	0.000	0.3	0.6	26.9	26.5
	30	100	0.001	0.000	0.5	0.5	27.0	26.8
	40	50	0.000	0.012	0.3	1.5	26.5	26.2
	25	50	0.000	0.002	0.4	0.3	27.0	26.4
	40	50	0.000	0.008	0.4	0.7	26.6	26.4
	30	***	0.000	0.003	0.3	0.2	26.8	26.1
	30	**	0.000	0.008	0.3	0.3	26.9	26.5

more in line with what would be expected. During the period of the short-term study, there was a considerable amount of local agricultural activity including the spraying of chemicals. This may be one possible explanation of the extremely high THC values.

Pollution roses from CO and THC were constructed with the April 17 - June 18 data using approximately the highest third of the concentration values for each given month. For example, the THC rose for June represents all values greater than or equal to 1.50 ppm, which was the one-third data breakoff point (i.e., in this particular case 32.8 percent all the THC measurements for that period). The pollution roses (Figures 3, 4, 6, 7, 9 and 10) therefore represent the percentage of the time for which the wind was coming from a given direction with simultaneous high values of THC or CO. The breakoff points and the percentage of each month's readings used for the CO and THC pollution roses are given in Table VI.

TABLE VI. BREAKOFF VALUES AND PERCENTAGES FOR POLLUTION ROSES

	April		May		June	
	THC	CO	THC	CO	THC	CO
≥ (ppm)	1.58	0.50	1.52	0.52	1.50	0.42
Percent of total data	32.0	34.5	29.5	28.8	32.8	29.7

In order that an analysis may be performed, wind roses were constructed using all of the wind measurements for each of the three months (Figures 5, 8 and 11). These offered a basis for comparison with the pollution roses. Using the pollution roses, determinations can then be made as to possible pollution sources in the Williams AFB area.

Note that the same general trend can be observed from the comparison of the wind roses and both pollution roses for each of the three time periods. This trend shows a higher percentage of relatively higher pollution values coming from the east and east-southeast directions.

In addition, the highest pollution values recorded, by month, for each pollutant, the time each occured, and the wind conditions at the time are given in Table VII.

HORIZONTAL WIND DISPERSION PARAMETER INVESTIGATION

The Pasquill stability class dispersion parameters are an important input to the approach used in AQAM. The purpose of the horizontal wind dispersion

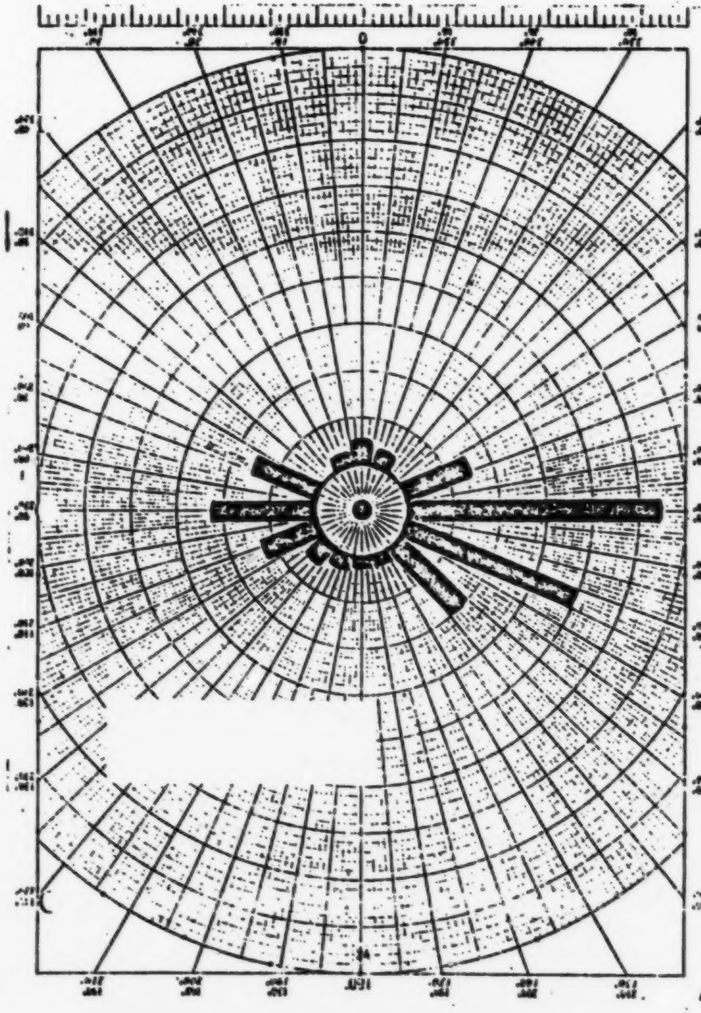


Figure 3. WAFB transmitter site THC pollution rose, April 1975.

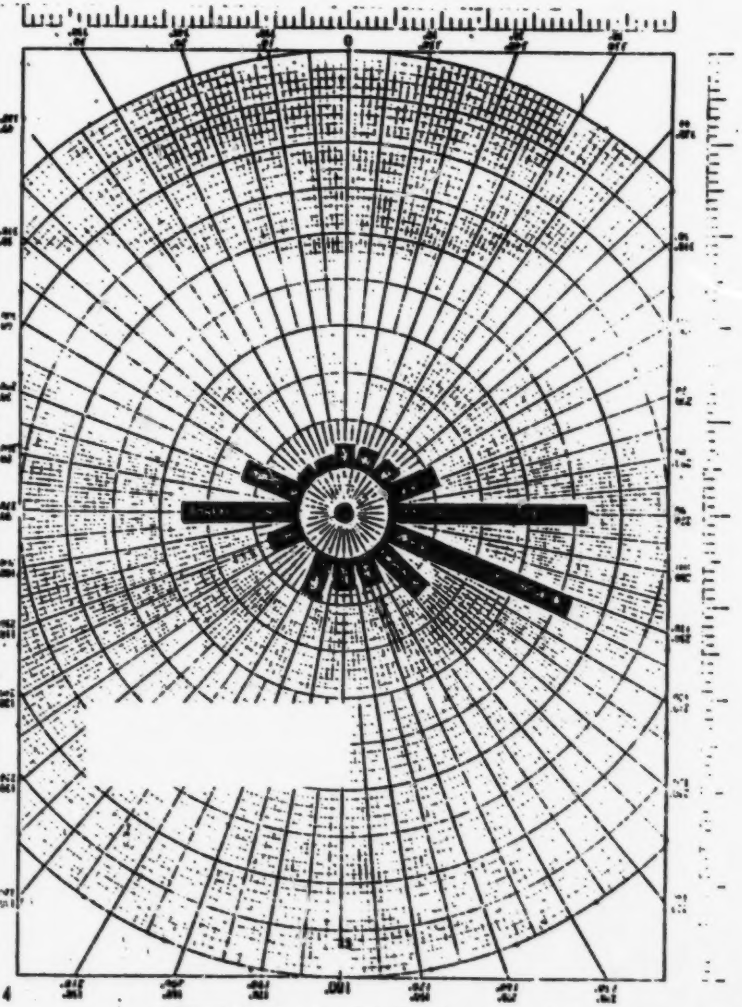


Figure 4. WAFB transmitter site CO pollution rose, April 1975.

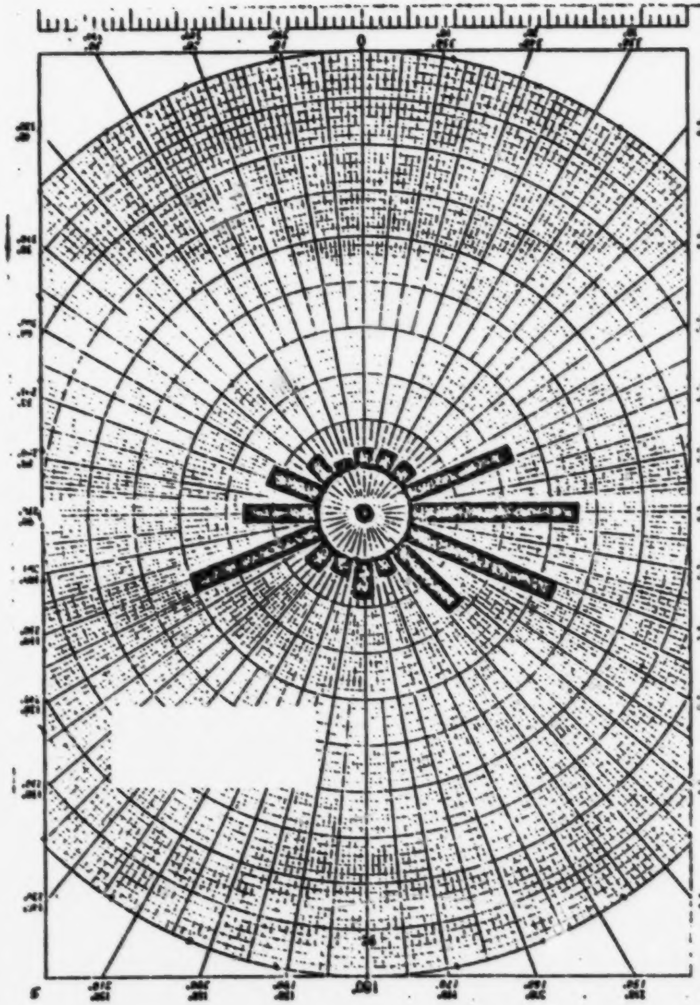


Figure 5. WAFB transmitter site wind rose, April 1975.

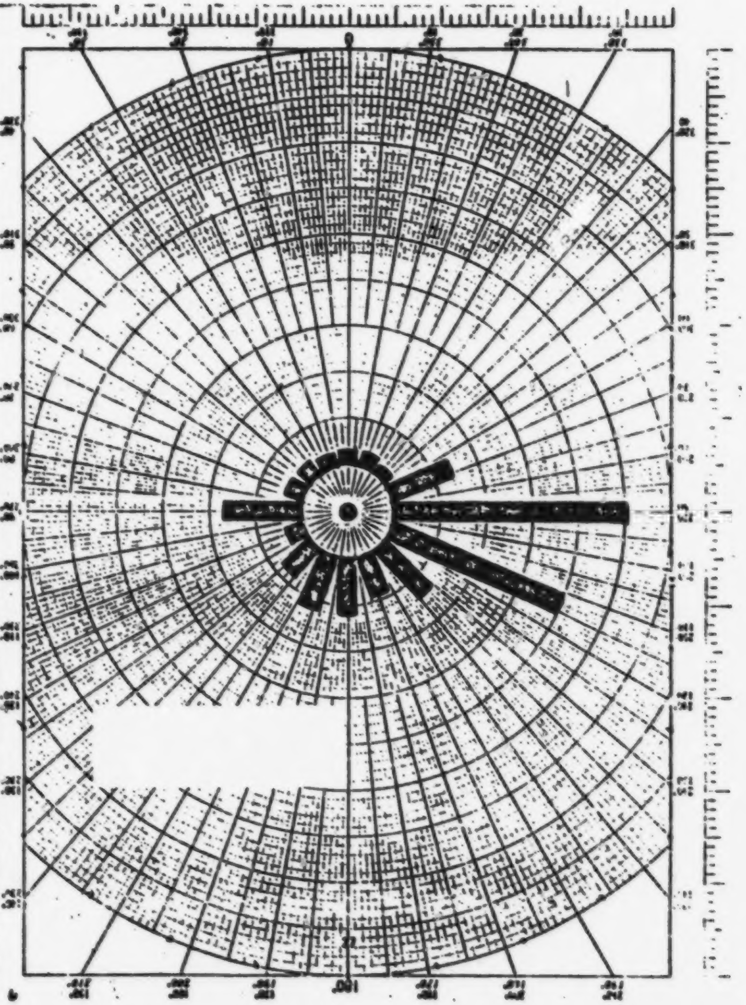


Figure 6. WAFB transmitter site THC pollution rose, May 1975.

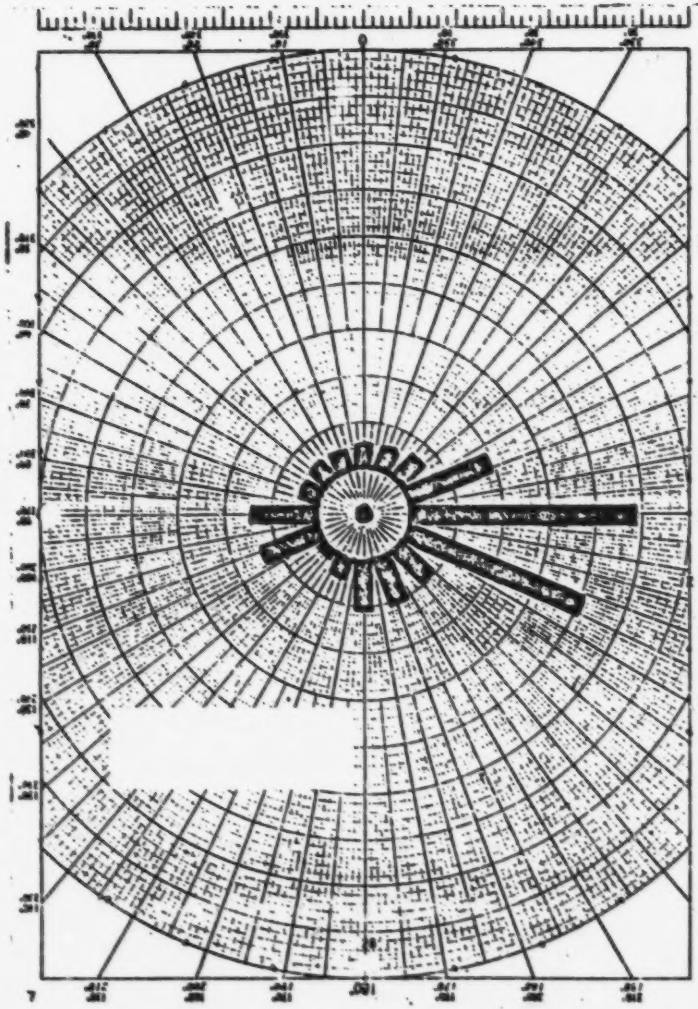


Figure 7. WAFB transmitter site CO pollution rose, May 1975.

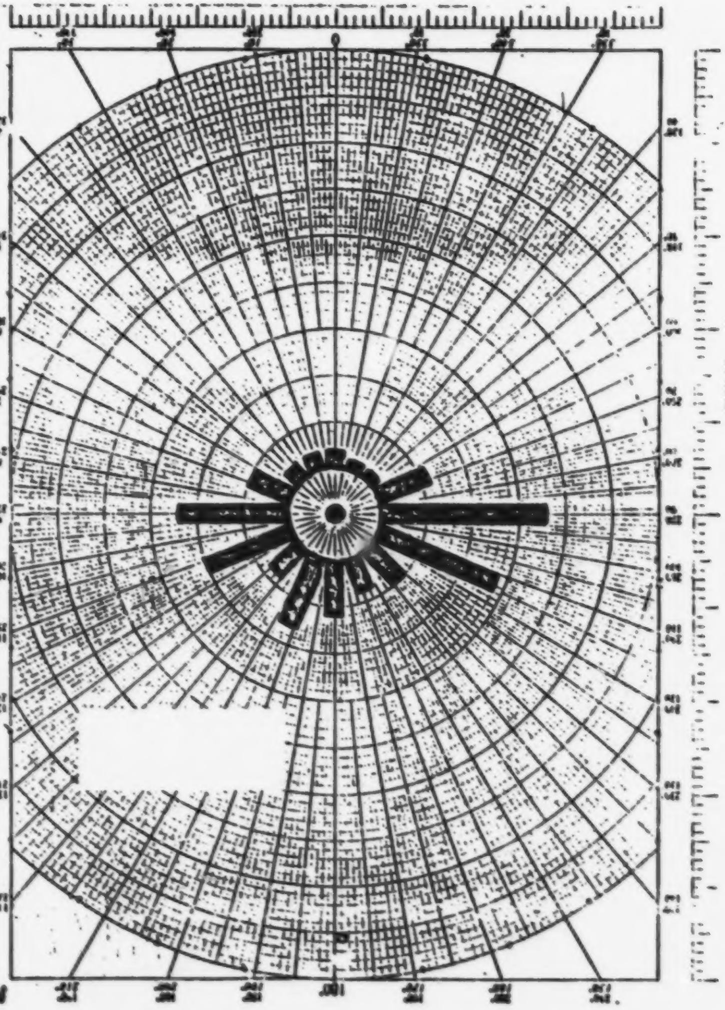


Figure 8. WAFB transmitter site wind rose, May 1975.

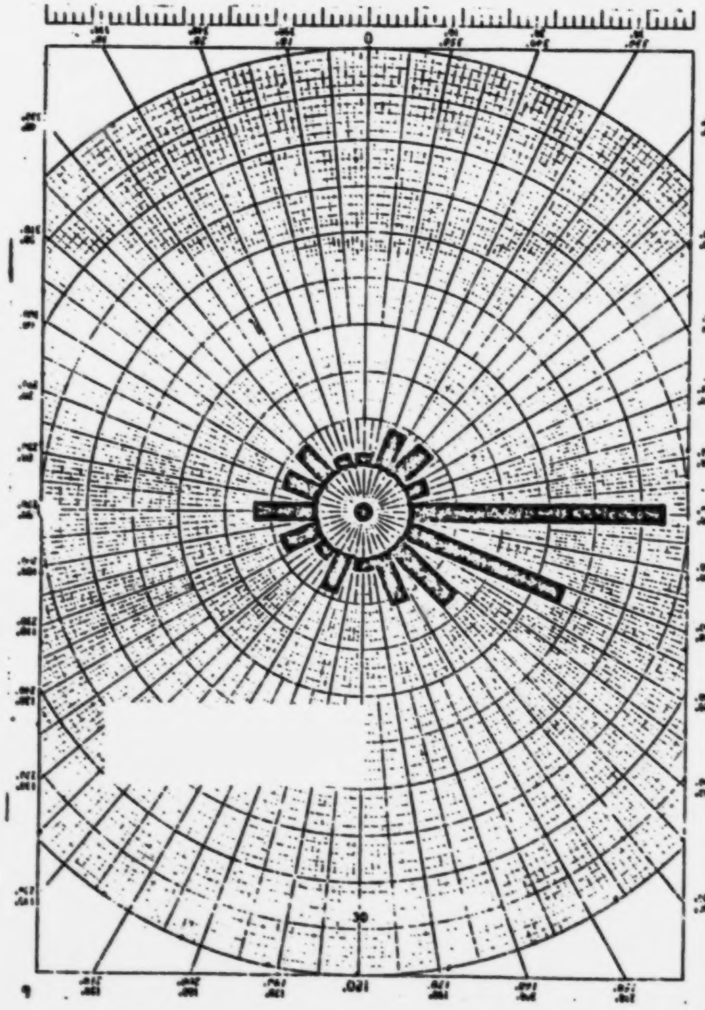


Figure 9. WAFB transmitter site THC pollution rose, June 1975.

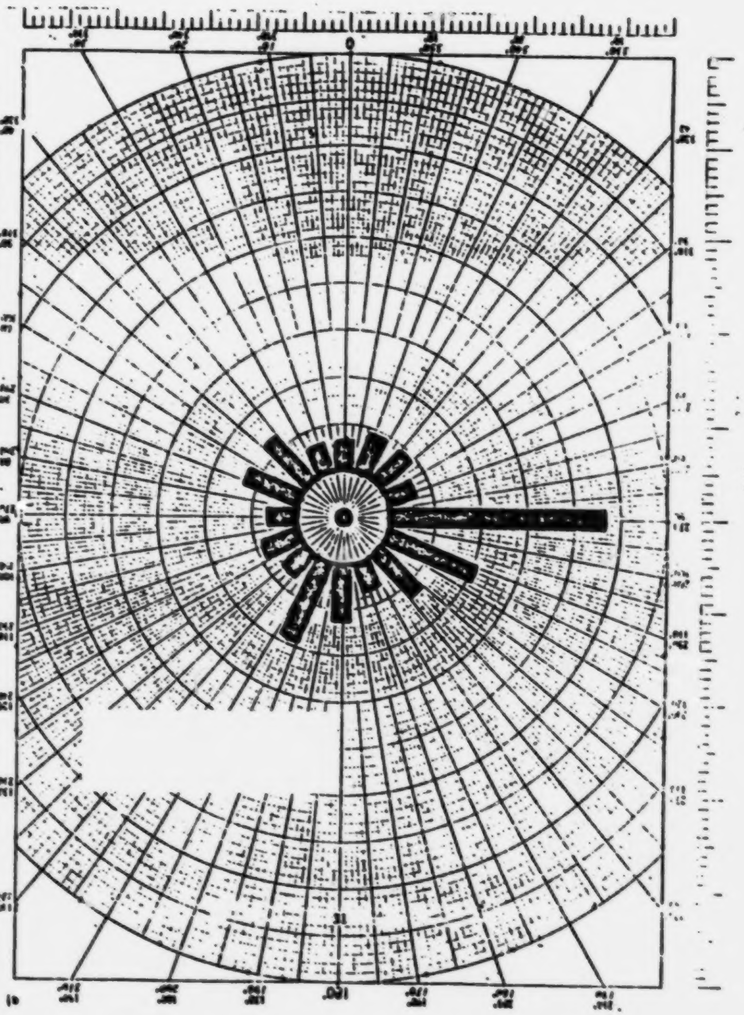


Figure 10. WAFB transmitter site CO pollution rose, June 1975.

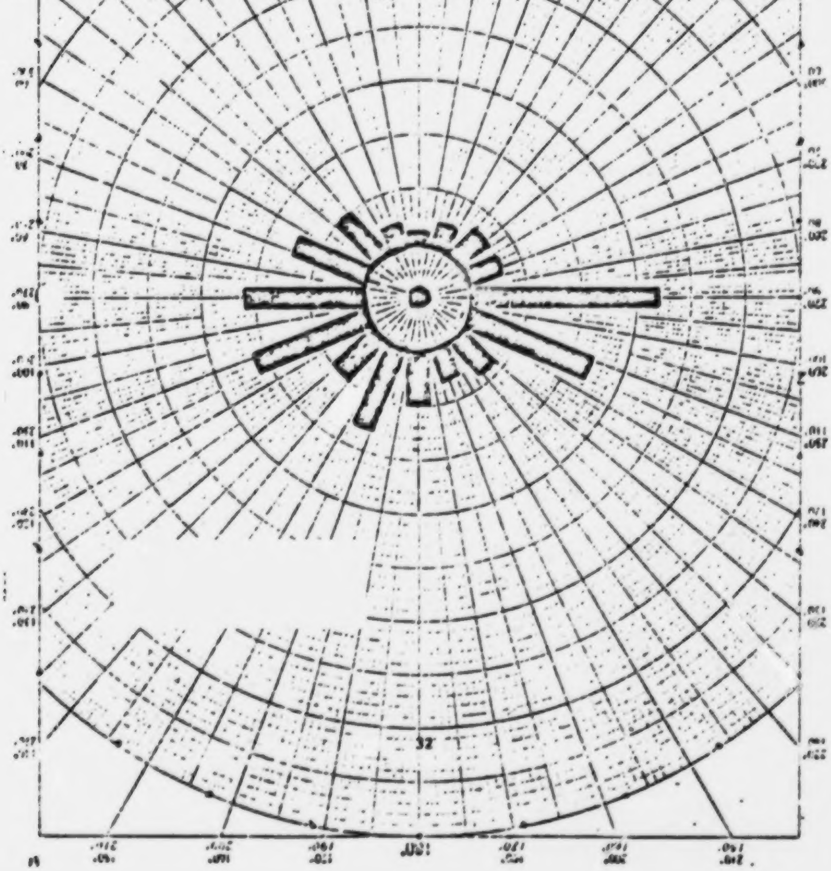


Figure 11. WAFB transmitter site wind rose, June 1975.

TABLE VII. SUMMARY OF HIGHEST MONTHLY VALUES

	Highest Value	Time		Wind	
		Day	Hour	Direction	Speed
April					
THC	1.80 ppm	30	0000-0100	195°	4.0
CH_4	1.65 ppm	19	0400-0500	130°	2.5
CO	1.8 ppm	19	2100-2200	100°	3.0
May					
THC	2.80 ppm	22	2200-2300	105°	2.5
CH_4	2.70 ppm	22	2200-2300	105°	2.5
CO	1.02 ppm	10	0000-0100	90°	2.0
June					
THC	2.50 ppm	13	2300-2400	135°	4.0
CH_4	2.50 ppm	13	2300-2400	135°	4.0
CO	1.30 ppm	17	2000-2100	200°	11.5

study was to determine how the subjective observation of stability class at WAFB (i.e., the method of determining stability class from WABAN observations [21]) compared with the measured horizontal dispersion values from propeller vane wind measurements and how this comparison would affect the AQAM results. A wind study was conducted at WAFB during the first week of monitoring -- June 1976 -- using the R. M. Young Gill propeller vanes. These vanes are light and have a fast time response. The average AGL height for the vanes was 8 m. Lightweight propeller vanes are effective for the measurement of WS in the 1 m to 10 m wavelength, which is an intermediate scale important to atmospheric diffusion.*

From June 1 to 8, 1976, strip-chart recordings of WS and WD were collected in seven periods of several hours each from all monitoring stations of the network. From these records, a shorter period of homogeneous turbulence (June 4 through 7) was selected for detailed analysis, when winds were generally light -- below 5 m/s. Maximum temperatures were in the mid 30's (°C) and minimums were in the low 20's, typical of summer weather in the Phoenix valley.

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* MacCready, P. B., Jr. and H. R. Jex. 1964. Response Characteristics and Meteorological Utilization of Propeller and Wind Vane Sensors. J. Appl. Meteorol. 3:182-193.

APPENDIX: AIR QUALITY DATA - APRIL 17 THROUGH JUNE 18, 1975

DATE	TIME	TMC	CH	CO	WIND DIRECTION	WIND SPEED
4-17	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600	2.20	1.50	.37		
	1600-1700	1.65	1.40	.37		
	1700-1800	1.40	1.40	.40		
	1800-1900	1.50	1.40	.40		
	1900-2000	1.40	1.40	.40		
	2000-2100	1.40	1.40	.35		
	2100-2200	1.45	1.45	.40		
	2200-2300	1.45	1.45	.35		
	2300-2400	1.45	1.45	.40		
	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					

DATE	TIME	TMC	CH	CO	WIND DIRECTION	WIND SPEED
4-18	0000-0100	1.45	1.45	.40		
	0100-0200	1.45	1.45	.35		
	0200-0300	1.45	1.45	.40		
	0300-0400	1.45	1.45	.40		
	0400-0500	1.45	1.45	.41		
	0500-0600	1.47	1.47	.41		
	0600-0700	1.47	1.47	.42		
	0700-0800	1.50	1.50	.40		
	0800-0900	1.50	1.50	.42		
	0900-1000	1.48	1.48	.43		
	1000-1100	1.46	1.46	.45		
	1100-1200	1.48	1.48	.45		
	1200-1300	1.48	1.48	.41		
	1300-1400	1.47	1.47	.45		
	1400-1500	1.50	1.50	.50		
	1500-1600	1.50	1.50	.50		
	1600-1700	1.50	1.50	.50		
	1700-1800	1.49	1.49	.49		
	1800-1900	1.48	1.48	.47		
	1900-2000	1.50	1.50	.50		
	2000-2100	*1.50 (2.5)	1.50	.50		
	2100-2200	1.51	1.51	.50		
	2200-2300	1.50	1.50	.50		
	2300-2400	1.50	1.50	.58		
4-19	0000-0100	1.50	1.50	.52	110	3.5
	0100-0200	1.50	1.50	.58	100	2.5
	0200-0300	1.50	1.50	.58	125	3.5
	0300-0400	1.57	1.57	.60	110	2.5
	0400-0500	1.65	1.65	.55	130	2.5
	0500-0600	1.62	1.62	.62	110	2.5
	0600-0700	1.57	1.50	.63	135	1.5
	0700-0800	1.50	1.50	.55	190	1.5
	0800-0900	1.50	1.50	.50	270	1.0
	0900-1000	1.50	1.50	.50	345	2.5
	1000-1100	1.50	1.50	.45	45	4.0
	1100-1200	1.47	1.47	.51	45	4.0
	1200-1300	1.47	1.47	.53	135	5.0
	1300-1400	1.47	1.47	.50	185	4.0
	1400-1500	1.45	1.45	.49	165	3.5
	1500-1600	1.45	1.45	.40	225	5.0
	1600-1700	1.42	1.42	.39	270	8.5
	1700-1800	1.45	1.45	.40	275	8.5
	1800-1900	1.42	1.42	.40	300	3.7
	1900-2000	1.43	1.40	.48	290	2.6
	2000-2100	1.55	1.50	.55	30	.5
	2100-2200	1.60	1.53	.80	100	3.0
	2200-2300	1.50	1.47	.50	115	2.9
	2300-2400	1.55	1.50	.60	100	3.0

* (= Peak value during hour.)

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
4-20	0000-0100	1.57	1.55	.53	85	4.0
	0100-0200	1.43	1.43	.45	90	4.0
	0200-0300	1.40	1.40	.40	105	4.0
	0300-0400	1.40	1.40	.40	85	4.0
	0400-0500	1.40	1.40	.40	75	3.5
	0500-0600	1.40	1.40	.41	75	2.5
	0600-0700	1.40	1.40	.42	105	3.0
	0700-0800	1.47	1.47	.45	120	5.0
	0800-0900	1.45	1.45	.47	125	4.0
	0900-1000	1.45	1.45	.51	125	2.0
	1000-1100	1.45	1.45	.50	30	3.0
	1100-1200	1.45	1.45	.48	210	4.0
	1200-1300	1.40	1.40	.45	235	4.5
	1300-1400	1.43	1.43	.43	240	4.0
	1400-1500	1.40	1.40	.40	255	7.0
	1500-1600	1.40	1.40	.40	270	6.5
	1600-1700	1.40	1.40	.38	285	6.5
	1700-1800	1.40	1.40	.38	275	3.0
	1800-1900	1.40	1.40	.35	340	2.8
	1900-2000	1.40	1.40	.45	10	2.4
	2000-2100	1.40	1.40	.43	55	2.8
	2100-2200	1.43	1.43	.50	115	1.5
	2200-2300	1.40	1.40	.50	165	3.5
	2300-2400	1.40	1.40	.43	115	4.0
4-21	0000-0100	1.40	1.40	.40	80	4.0
	0100-0200	1.40	1.40	.40	90	4.5
	0200-0300	1.40	1.40	.37	115	3.5
	0300-0400	1.45	1.45	.35	85	4.0
	0400-0500	1.43	1.43	.40	90	4.0
	0500-0600	1.40	1.40	.40	80	4.5
	0600-0700	1.40	1.40	.40	105	4.5
	0700-0800	1.48	1.48	.48	130	4.5
	0800-0900	1.48	1.48	.45	220	1.5
	0900-1000	1.40	1.40	.43	315	2.0
	1000-1100	1.40	1.40	.40	15	3.0
	1100-1200	1.40	1.40	.40	130	2.0
	1200-1300	1.40	1.40	.40	115	4.5
	1300-1400	1.40	1.40	.38	195	6.5
	1400-1500	1.40	1.40	.37	180	7.0
	1500-1600	1.40	1.40	.35	175	4.0
	1600-1700	1.40	1.40	.40	240	6.0
	1700-1800	1.40	1.40	.40	240	6.5
	1800-1900	1.45	1.45	.53	245	3.0
	1900-2000	1.47	1.47	.53	185	1.0
	2000-2100	1.50	1.50	.58	195	4.0
	2100-2200	1.40	1.40	.58	195	3.5
	2200-2300	1.48	1.48	.50	360	1.5
	2300-2400	1.50	1.50	.48	45	3.5

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
4-22	0000-0100	1.50	1.50	.40	75	4
	0100-0200	1.47	1.47	.40	75	3
	0200-0300	1.43	1.43	.40	75	4.5
	0300-0400	1.40	1.40	.40	65	4
	0400-0500	1.40	1.40	.37	85	4.5
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					
4-23	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
4-24	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000	1.40	1.40	.50		
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					
4-25	0000-0100				85	2.5
	0100-0200	1.70	1.60	.75	90	3
	0200-0300	1.65	1.60	.70	85	3.5
	0300-0400	1.60	1.50	.55	90	4
	0400-0500	1.60	1.57	.50	105	5
	0500-0600	1.60	1.50	.50	80	4
	0600-0700	1.60	1.50	.50	75	3.5
	0700-0800	1.60	1.57	.47	85	4
	0800-0900	1.57	1.50	.43	105	6
	0900-1000				105	7.5
	1000-1100				135	5.5
	1100-1200	1.53	1.50	.44	145	7
	1200-1300	1.50	1.48	.41	145	8
	1300-1400	1.50	1.42	.44		
	1400-1500	1.50	1.48	.45	5	
	1500-1600	1.50	1.45	.42	3	
	1600-1700	1.55	1.43	.43	0	
	1700-1800	1.50	1.45	.47	0	
	1800-1900	1.52	1.47	.45		
	1900-2000	1.58	1.48	.45		
	2000-2100	1.60	1.57	.45		
	2100-2200	1.51	1.50	.48		
	2200-2300	1.63	1.50	.50		
	2300-2400	1.58	1.47	.53		

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
4-26	0000-0100	1.5	1.43	.43		
	0100-0200	1.52	1.48	.43		
	0200-0300	1.50	1.47	.45	5	
	0300-0400	1.50	1.47	.45	0	
	0400-0500	1.52	1.48	.43	0	
	0500-0600	1.53	1.50	.47		
	0600-0700	1.51	1.48	.43		
	0700-0800	1.50	1.43	.42		
	0800-0900	1.58	1.50	.45		
	0900-1000	1.58	1.50	.49		
	1000-1100	1.60	1.53	.48		
	1100-1200	1.58	1.50	.45	250	6.5
	1200-1300	1.58	1.50	.48	285	9.5
	1300-1400	1.58	1.50	.43	230	12
	1400-1500	1.52	1.45	.43	220	14
	1500-1600	1.57	1.43	.46	240	15
	1600-1700	1.57	1.50	.45	240	15
	1700-1800	1.57	1.48	.43	250	14
	1800-1900	1.55	1.50	.43	265	13
	1900-2000	1.59	1.50	.50	255	9.5
	2000-2100	1.60	1.50	.54	255	7
	2100-2200	1.61	1.58	.54	265	6
	2200-2300	1.60	1.57	.52	270	8
	2300-2400	1.60	1.55	.50	245	6.5
4-27	0000-0100	1.65	1.60	.47	295	1.5
	0100-0200	1.63	1.60	.47	145	2
	0200-0300	1.57	1.50	.45	320	3
	0300-0400	1.58	1.50	.45	145	1.5
	0400-0500	1.58	1.50	.44	115	2.5
	0500-0600	1.59	1.51	.43	90	3
	0600-0700	1.60	1.54	.45	100	3
	0700-0800	1.60	1.52	.50	120	3.5
	0800-0900	1.60	1.57	.48	135	3.5
	0900-1000	1.60	1.54	.47	140	3
	1000-1100	1.59	1.50	.44	235	4
	1100-1200	1.57	1.50	.45	290	4
	1200-1300	1.55	1.51	.40	245	7
	1300-1400	1.58	1.50	.41	255	7
	1400-1500	1.58	1.50	.41	270	8
	1500-1600	1.58	1.50	.42	270	8.5
	1600-1700	1.58	1.53	.43	260	7.5
	1700-1800	1.51	1.50	.40	260	6
	1800-1900	1.54	1.51	.45	285	3.5
	1900-2000	1.58	1.50	.45	345	1.5
	2000-2100	1.59	1.50	.50	95	2.5
	2100-2200	1.59	1.55	.43	70	3
	2200-2300	1.60	1.52	.45	110	3
	2300-2400	1.61	1.57	.50	120	3.5

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
4-28	0000-0100	1.63	1.60	.50	115	3
	0100-0200	1.63	1.58	.50	105	3
	0200-0300	1.70	1.60	.53	95	3
	0300-0400	1.70	1.62	.52	90	3.5
	0400-0500	1.62	1.55	.53	80	3
	0500-0600	1.60	1.50	.45	105	3.5
	0600-0700	1.60	1.50	.50	85	4
	0700-0800	1.60	1.50	.48	110	6
	0800-0900	1.60	1.50	.47	125	4
	0900-1000	1.58	1.51	.47	355	2
	1000-1100	1.57	1.50	.50	270	4
	1100-1200	1.59	1.50	.55	270	6.5
	1200-1300	1.59	1.59	.48	270	5.5
	1300-1400	1.55	1.45	.48	250	6.5
	1400-1500	1.50	1.45	.43	250	6
	1500-1600	1.52	1.47	.40	250	6.5
	1600-1700	1.50	1.45	.40	240	6
	1700-1800	1.55	1.45	.40	240	5
	1800-1900	1.54	1.45	.40	215	3
	1900-2000	1.53	1.47	.40	150	3
	2000-2100	1.58	1.49	.50	95	2
	2100-2200	1.60	1.53	.49	75	4.5
	2200-2300	1.61	1.55	.44	85	3.5
	2300-2400	1.60	1.50	.43	90	3
4-29	0000-0100	1.55	1.50	.45	115	3.5
	0100-0200	1.58	1.43	.45	90	3
	0200-0300	1.58	1.43	.60	90	4
	0300-0400	1.55	1.45	.45	90	5
	0400-0500	1.58	1.50	.45	85	3.5
	0500-0600	1.55	1.50	.40	90	5
	0600-0700	1.58	1.50	.42	105	6
	0700-0800	1.58	1.50	.42	120	6.5
	0800-0900	1.60	1.50	.45	180	2
	0900-1000	1.60	1.55	.52	285	3
	1000-1100	1.59	1.50	.50	265	6
	1100-1200	1.59	1.50	.50	245	7
	1200-1300	1.60	1.50	.50	290	7.5
	1300-1400	1.57	1.43	.50	285	9.5
	1400-1500	1.57	1.43	.45	275	12
	1500-1600	1.55	1.47	.40	255	13
	1600-1700	1.53	1.43	.40	255	12
	1700-1800	1.55	1.44	.44	260	9
	1800-1900	1.57	1.44	.48	270	6.5
	1900-2000	1.60	1.43	.45	285	5.5
	2000-2100	1.60	1.44	.52	285	5
	2100-2200	1.60	1.45	.54	270	4
	2200-2300	1.62	1.51	.50	355	2
	2300-2400	1.78	1.58	.75	150	2.5

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
4-30	0000-0100	1.79	1.50	.75	195	4
	0100-0200	1.80	1.60	.72	110	3
	0200-0300	1.75	1.57	.65	75	4.5
	0300-0400	1.63	1.58	.62	75	4
	0400-0500	1.62	1.58	.53	85	4
	0500-0600	1.60	1.50	.50	90	4
	0600-0700	1.60	1.50	.48	95	5.5
	0700-0800	1.60	1.50	.50	120	7
	0800-0900	1.60	1.58	.50	120	8
	0900-1000	1.60	1.52	.45	125	7
	1000-1100	1.55	1.48	.38	180	4
	1100-1200	1.52	1.43	.40	180	5
	1200-1300	1.51	1.42	.40	255	5
	1300-1400	1.50	1.43	.40	240	6.5
	1400-1500	1.50	1.42	.40	230	6
	1500-1600	1.50	1.42	.40	260	5.5
	1600-1700	1.50	1.40	.40	280	5.8
	1700-1800	1.50	1.44	.40	310	6
	1800-1900	1.50	1.45	.40	320	4
	1900-2000	1.54	1.48	.43	15	3
	2000-2100	1.60	1.45	.60	15	3
	2100-2200	1.60	1.45	.75	60	3
	2200-2300	1.60	1.47	.67	120	3.5
	2300-2400	1.60	1.50	.55	125	3
	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/1	0000-0100	1.78	1.60	.60	85	4
	0100-0200	1.85	1.75	.58	75	6
	0200-0300	1.63	1.57	.50	75	5
	0300-0400	1.58	1.50	.50	80	6
	0400-0500	1.75	1.70	.40	105	5
	0500-0600	1.75	1.68	.40	110	4
	0600-0700	1.60	1.55	.45	110	4.5
	0700-0800	1.60	1.55	.50	130	5.5
	0800-0900	1.60	1.60	.50	125	8.5
	0900-1000	1.54	1.50	.40	140	9
	1000-1100	1.52	1.49	.40	140	7.5
	1100-1200	1.53	1.50	.40	180	7
	1200-1300	1.52	1.42	.40	215	7
	1300-1400	1.47	1.40	.38	215	11
	1400-1500	1.48	1.40	.38	240	13
	1500-1600	1.48	1.40	.35	240	13
	1600-1700	1.47	1.40	.40	250	10.5
	1700-1800	1.47	1.43	.40	260	10.5
	1800-1900	1.50	1.43	.40	280	7.5
	1900-2000	1.53	1.48	.45	285	5
	2000-2100	1.63	1.55	.63	350	1.5
	2100-2200	1.68	1.55	.70	90	1.5
	2200-2300	1.63	1.55	.70	100	4
	2300-2400	1.65	1.58	.63	90	3
5/2	0000-0100	1.63	1.55	.60	90	4
	0100-0200	1.62	1.55	.50	50	4.5
	0200-0300	1.60	1.50	.45	90	4.5
	0300-0400	1.58	1.50	.40	90	5
	0400-0500	1.54	1.45	.35	75	4
	0500-0600	1.53	1.45	.35	90	3.5
	0600-0700	1.52	1.42	.35	105	4.5
	0700-0800	1.53	1.48	.4	120	7.5
	0800-0900	1.50	1.48	.38	120	5.5
	0900-1000	1.50	1.43	.38	150	6.5
	1000-1100	1.50	1.42	.38	120	4
	1100-1200	1.80	1.47	.35	180	4.5
	1200-1300	1.50	1.42	.40	270	7
	1300-1400	1.50	1.40	.40	270	8.5
	1400-1500	1.50	1.40	.40	270	7
	1500-1600	1.50	1.43	.40	270	6
	1600-1700	1.50	1.40	.40	270	5.5
	1700-1800	1.50	1.42	.50	255	5
	1800-1900	1.55	1.48	.50	225	3
	1900-2000	1.58	1.43	.49	165	2.5
	2000-2100	1.60	1.50	.60	105	3
	2100-2200	1.80	1.70	.63	90	3
	2200-2300	1.65	1.60	.50	90	3.5
	2300-2400	1.60	1.50	.50	70	4

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/3	0000-0100	1.58	1.47	.50	115	3
	0100-0200	1.59	1.50	.55	120	4
	0200-0300	1.75	1.62	.60	105	3
	0300-0400	1.80	1.67	.50	90	4.5
	0400-0500	1.60	1.50	.50	75	4
	0500-0600	1.60	1.50	.50	85	4.5
	0600-0700	1.60	1.50	.49	90	6
	0700-0800	1.55	1.47	.45	115	6
	0800-0900	1.55	1.45	.42	135	7
	0900-1000	1.55	1.50	.40	155	6
	1000-1100	1.53	1.43	.40	230	4.5
	1100-1200	1.50	1.42	.40	270	5
	1200-1300	1.55	1.40	.40	280	6.5
	1300-1400	1.55	1.40	.37	270	6
	1400-1500					
	1500-1600	1.60	1.58	.45	270	7
	1600-1700	1.60	1.55	.45	280	8
	1700-1800	1.60	1.55	.47	300	6.5
	1800-1900	1.60	1.57	.50	330	3.5
	1900-2000	1.64	1.60	.55	375	2
	2000-2100	1.68	1.60	.68	45	2
	2100-2200	1.70	1.60	.65	120	3
	2200-2300	1.70	1.60	.70	165	4
	2300-2400	1.60	1.58	.43	210	5
5/4	0000-0100	1.60	1.58	.47	140	5
	0100-0200	1.62	1.60	.55	95	7
	0200-0300	1.58	1.57	.52	75	7
	0300-0400	1.58	1.55	.50	75	5
	0400-0500	1.58	1.55	.48	75	5
	0500-0600	1.57	1.53	.48	105	6
	0600-0700	1.58	1.57	.47	115	8.5
	0700-0800	1.58	1.57	.40	120	8.5
	0800-0900	1.57	1.53	.40	130	11
	0900-1000	1.57	1.55	.40	165	11
	1000-1100	1.57	1.55	.40	180	11
	1100-1200	1.53	1.50	.40	190	12
	1200-1300	1.53	1.50	.38	195	16
	1300-1400	1.52	1.50	.38	180	15
	1400-1500	1.52	1.50	.37	190	17
	1500-1600	1.50	1.45	.38	185	17
	1600-1700	1.50	[illegible]	.37	210	17
	1700-1800	1.51	1.49	.38	225	18
	1800-1900	1.52	1.50	.38	210	11.5
	1900-2000	1.55	1.55	.38	210	13
	2000-2100	1.55	1.50	.40	200	13
	2100-2200	1.50	1.48	.40	200	9
	2200-2300	1.58	1.55	.40	185	8.5
	2300-2400	1.58	1.55	.38	165	6.5

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/5	0000-0100	1.55	1.55	.38	185	7
	0100-0200	1.55	1.55	.40	200	8
	0200-0300	1.57	1.55	.40	210	9
	0300-0400	1.57	1.55	.40	195	10
	0400-0500	1.60	1.55	.43	210	11
	0500-0600	1.60	1.58	.45	200	9
	0600-0700	1.60	1.57	.50	215	11
	0700-0800	1.60	1.57	.50	210	13
	0800-0900	1.60	1.58	.45	210	12
	0900-1000	1.58	1.56	.43	210	13.5
	1000-1100	1.57	1.55	.43	240	9
	1100-1200	1.58	1.55	.40	260	11.5
	1200-1300	1.55	1.50	.42	260	10
	1300-1400	1.55	1.50	.43	250	12
	1400-1500	1.57	1.55	.40	265	11
	1500-1600	1.55	1.50	.40	265	12
	1600-1700	1.55	1.50	.40	275	9.5
	1700-1800	1.57	1.55	.45	275	12.5
	1800-1900	1.58	1.55	.50	275	11
	1900-2000	1.60	1.57	.50	275	7
	2000-2100	1.61	1.58	.50	280	4
	2100-2200	1.60	1.57	.50	215	2.5
	2200-2300	1.63	1.60	.53	130	2.5
	2300-2400	1.63	1.6[illegible]	.50	90	3
5/6	0000-0100	1.65	1.60	.53	65	3.5
	0100-0200	1.70	1.63	.55	105	3
	0200-0300	1.80	1.75	.60	85	3
	0300-0400	1.63	1.60	.55	90	3.5
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100	1.50	1.50	.88	120	3
	2100-2200	1.75	1.75	.93	105	3
	2200-2300	1.65	1.65	.55	75	3
	2300-2400	1.50	1.50	.53	90	4

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/7	0000-0100	1.50	1.50	.50	105	3.5
	0100-0200	1.58	1.58	.53	105	4
	0200-0300	1.60	1.60	.49	80	3.5
	0300-0400	1.58	1.58	.49	115	3.5
	0400-0500	1.58	1.58	.47	90	3.5
	0500-0600	1.50	1.50	.43	75	5
	0600-0700	1.44	1.44	.47	120	3
	0700-0800	1.60	1.60	.50	125	4
	0800-0900	1.55	1.55	.49	150	4
	0900-1000	1.50	1.50	.47	135	4.5
	1000-1100	1.57	1.57	.48	155	3.5
	1100-1200	1.52	1.52	.47	150	4.5
	1200-1300	1.52	1.52	.50	225	5
	1300-1400	1.52	1.52	.50	260	8
	1400-1500	1.57	1.57	.48	270	7
	1500-1600	1.55	1.55	.48	270	9
	1600-1700	1.53	1.53	.46	260	6
	1700-1800	1.50	1.50	.47	265	5
	1800-1900	1.52	1.52	.51	310	4
	1900-2000	1.55	1.55	.53	330	2.5
	2000-2100	1.60	1.60	.55	45	2.5
	2100-2200	1.60	1.60	.63	75	3.5
	2200-2300	1.60	1.60	.70	120	3.5
	2300-2400	1.65	1.65	.72	95	4
5/8	0000-0100	1.60	1.60	.55	105	4
	0100-0200	1.67	1.67	.53	95	3
	0200-0300	1.60	1.60	.52	70	35
	0300-0400	1.60	1.60	.51	90	5.5
	0400-0500	1.60	1.60	.53	85	5
	0500-0600	1.60	1.60	.53	90	5
	0600-0700	1.60	1.60	.52	95	4
	0700-0800	1.60	1.60	.51	115	6
	0800-0900	1.57	1.57	.52	130	5
	0900-1000	1.58	1.58	.51	165	3
	1000-1100	1.57	1.57	.50	200	4.5
	1100-1200	1.56	1.56	.55	245	5.5
	1200-1300	1.58	1.58	.52	285	4.5
	1300-1400	1.57	1.57	.47	150	5
	1400-1500	1.58	1.58	.48	300	9
	1500-1600	1.52	1.52	.48	295	6
	1600-1700	1.54	1.54	.48	300	6
	1700-1800	1.53	1.53	.47	310	6
	1800-1900	1.55	1.55	.48	330	5
	1900-2000	1.55	1.55	.52	350	3
	2000-2100	1.58	1.58	.81	360	3
	2100-2200	1.58	1.58	.82	50	3.5
	2200-2300	1.60	1.60	.65	90	3
	2300-2400	1.57	1.57	.50	75	2.5

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/9	0000-0100	1.58	1.58	.50	115	4
	0100-0200	1.60	1.60	.50	100	2.5
	0200-0300	1.60	1.60	.50	110	5.5
	0300-0400	1.60	1.60	.50	95	5
	0400-0500	1.60	1.60	.60	105	5
	0500-0600	1.60	1.60	.52	70	3
	0600-0700	1.58	1.58	.52	65	2.5
	0700-0800	1.58	1.58	.48	90	5.5
	0800-0900	1.58	1.58	.48	105	6
	0900-1000	1.58	1.58	.46	30	3
	1000-1100	1.55	1.55	.48	260	2.5
	1100-1200	1.53	1.53	.48	295	3
	1200-1300	1.55	1.55	.50	280	4.5
	1300-1400	1.57	1.57	.49	290	5
	1400-1500	1.57	1.57	.50	190	5
	1500-1600	1.56	1.56	.50	290	6
	1600-1700	1.58	1.58	.48	270	9
	1700-1800	1.58	1.58	.50	260	8
	1800-1900	1.60	1.60	.50	260	7
	1900-2000	1.61	1.61	.52	310	4
	2000-2100	1.65	1.65	.80	310	4.5
	2100-2200	1.65	1.65	.85	335	3.5
	2200-2300	1.60	1.60	.81	125	2
	2300-2400					
5/10	0000-0100	1.33	1.42	1.02	90	2
	0100-0200	1.50	1.40	1.00	105	2
	0200-0300	1.63	1.63	.98	115	3
	0300-0400	1.63	1.63	.82	100	3
	0400-0500	1.60	1.60	.66	60	3
	0500-0600	1.60	1.60	.57	90	3
	0600-0700	1.60	1.60	.54	60	2.5
	0700-0800	1.60	1.60	.56	105	5.5
	0800-0900	1.60	1.60	.62	105	6
	0900-1000	1.60	1.60	.62	105	7
	1000-1100	1.60	1.60	.62	150	5
	1100-1200	1.57	1.57	.48	250	4
	1200-1300	1.57	1.57	.49	235	5
	1300-1400	1.57	1.57	.52	265	8
	1400-1500	1.53	1.53	.50	265	8.5
	1500-1600	1.48	1.48	.47	255	11
	1600-1700	1.50	1.50	.44	260	11.5
	1700-1800	1.48	1.48	.45	270	9.5
	1800-1900	1.50	1.50	.48	270	6.5
	1900-2000	1.53	1.53	.53	270	2.5
	2000-2100	1.58	1.58	.61	10	1.5
	2100-2200	1.60	1.60	.62	65	3
	2200-2300	1.60	1.60	.65	100	3
	2300-2400	1.61	1.61	.70	95	4

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/11	0000-0100	1.68	1.68	.92	130	3.5
	0100-0200	1.67	1.67	.72	105	4.5
	0200-0300	1.58	1.58	.62	90	4
	0300-0400	1.5800	1.58	.50	90	5.5
	0400-0500	1.57	1.57	.50	90	4
	0500-0600	1.60	1.60	.53	90	4.5
	0600-0700	1.58	1.58	.50	100	5
	0700-0800	1.56	1.56	.48	110	7.5
	0800-0900	1.58	1.58	.47	130	7
	0900-1000	1.52	1.52	.48	120	3
	1000-1100	1.52	1.52	.45	145	3.5
	1100-1200	1.50	1.50	.47	210	3.5
	1200-1300	1.50	1.50	.41	210	4.5
	1300-1400	1.50	1.50	.43	245	8
	1400-1500	1.46	1.46	.47	245	8
	1500-1600	1.44	1.44	.44	265	9
	1600-1700	1.50	1.50	.42	270	6
	1700-1800	1.50	1.50	.43	285	5.5
	1800-1900	1.55	1.55	.45	300	5
	1900-2000	1.55	1.55	.51	330	1
	2000-2100	1.58	1.59	.52	80	3
	2100-2200	1.58	1.58	.51	100	3
	2200-2300	1.50	1.58	.50	90	3.5
	2300-2400	1.75	1.70	.50	90	3.5
5/12	0000-0100	1.73	1.75	.50	110	4.5
	0100-0200	1.70	1.70	.50	110	6
	0200-0300	1.58	1.58	.50	80	5
	0300-0400	1.48	1.48	.44	90	4.5
	0400-0500	1.50	1.50	.42	90	4.5
	0500-0600	1.60	1.60	.50	90	5.5
	0600-0700	1.58	1.58	.45	95	5.5
	0700-0800	1.75	1.75	.48	95	6.5
	0800-0900	1.53	1.53	.44	120	5.5
	0900-1000	1.55	1.55	.48	125	5
	1000-1100	1.50	1.50	.48	180	3.5
	1100-1200	1.53	1.53	.46	180	4.5
	1200-1300	1.47	1.47	.46	255	6
	1300-1400	1.50	1.50	.47	265	9.5
	1400-1500	1.47	1.47	.46	240	8
	1500-1600	1.50	1.50	.48	255	6
	1600-1700	1.50	1.50	.48	260	9
	1700-1800	1.47	1.47	.48	250	7.5
	1800-1900	1.53	1.53	.47	210	5
	1900-2000	1.58	1.58	.50	180	3
	2000-2100	1.53	1.53	.50	185	5
	2100-2200	1.56	1.56	.50	185	4.5
	2200-2300	1.56	1.56	.49	170	2.5
	2300-2400	1.54	1.54	.50	65	2.5

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/13	0000-0100	1.55	1.55	.49	270	3.5
	0100-0200	1.59	1.59	.45	90	3
	0200-0300	1.55	1.55	.44	100	4
	0300-0400	1.58	1.58	.46	95	4
	0400-0500	1.58	1.58	.42	85	3.5
	0500-0600	1.58	1.58	.41	75	4.5
	0600-0700	1.58	1.58	.42	105	7.5
	0700-0800	1.59	1.59	.43	120	8.5
	0800-0900	1.60	1.60	.42	105	8
	0900-1000	1.58	1.58	.46	145	6.5
	1000-1100	1.50	1.50	.40	145	5
	1100-1200	1.42	1.42	.40	130	5
	1200-1300	1.42	1.42	.39	155	4.5
	1300-1400	1.42	1.42	.41	205	4.5
	1400-1500	1.42	1.42	.42	260	6
	1500-1600	1.40	1.40	.42	260	6
	1600-1700	1.41	1.41	.43	270	8
	1700-1800	1.42	1.42	.41	250	5.5
	1800-1900	1.45	1.45	.50	240	4
	1900-2000	1.58	1.58	.60	250	2
	2000-2100	1.60	1.58	.70	320	3
	2100-2200	1.58	1.58	.62	95	3.5
	2200-2300	1.60	1.59	.53	90	3
	2300-2400	1.58	1.56	.52	.05	4
5/14	0000-0100	1.55	1.55	.50	90	3.5
	0100-0200	1.56	1.53	.48	80	4.5
	0200-0300	1.54	1.54	.47	80	5
	0300-0400	1.50	1.50	.43	90	4
	0400-0500	1.53	1.53	.40	85	3.5
	0500-0600	1.50	1.47	.43	90	3
	0600-0700	1.54	1.49	.40	105	5
	0700-0800	1.53	1.50	.40	110	8
	0800-0900	1.50	1.50	.40	110	7
	0900-1000	1.43	1.43	.41	160	3
	1000-1100	1.43	1.43	.41	240	3.5
	1100-1200	1.47	1.47	.48	255	5
	1200-1300	1.50	1.50	.45	275	7
	1300-1400	1.50	1.50	.40	275	6.5
	1400-1500	1.42	1.42	.38	255	8
	1500-1600	1.40	1.40	.38	260	8.5
	1600-1700	1.40	1.40	.39	270	8.5
	1700-1800	1.42	1.40	.40	285	7
	1800-1900	1.42	1.40	.45	300	5.5
	1900-2000	1.65	1.60	.50	320	3
	2000-2100	1.60	1.55	.68	20	1
	2100-2200	1.58	1.50	.60	120	1
	2200-2300	1.60	1.56	.62	90	3.5
	2300-2400	1.60	1.57	.60	95	4

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/15	0000-0100	1.57	1.50	.55	105	3
	0100-0200	1.75	1.65	.60	105	2.5
	0200-0300	1.70	1.50	.50	105	3.5
	0300-0400	1.60	1.38	.50	95	3.5
	0400-0500	1.50	1.45	.47	90	3.5
	0500-0600	1.50	1.46	.42	85	4
	0600-0700	1.53	1.48	.42	90	3.5
	0700-0800	1.55	1.55	.45	60	3
	0800-0900	1.49	1.42	.43	330	1.5
	0900-1000	1.58	1.40	.67	270	3
	1000-1100	1.50	1.40	.50	270	4
	1100-1200	1.42	1.40	.50	270	5
	1200-1300	1.40	1.40	.40	275	4
	1300-1400	1.40	1.40	.40	220	4.5
	1400-1500	1.40	1.40	.42	270	5.5
	1500-1600	1.42	1.40	.40	265	9
	1600-1700	1.43	1.40	.41	270	8.5
	1700-1800	1.40	1.40	.40	270	8
	1800-1900	1.40	1.40	.42	295	3
	1900-2000	1.60	1.43	.70	275	3.5
	2000-2100	1.60	1.48	.63	235	3.5
	2100-2200	1.40	1.40	.40	210	7
	2200-2300	1.40	1.40	.38	275	2.5
	2300-2400	1.55	1.50	.40	120	7
5/16	0000-0100	1.60	1.60	.42	130	5.5
	0100-0200	1.55	1.43	.40	95	5
	0200-0300	1.50	1.42	.39	110	6
	0300-0400	1.40	1.40	.35	110	5.5
	0400-0500	1.40	1.40	.33	75	4
	0500-0600	1.55	1.55	.40	120	2.5
	0600-0700	1.52	1.52	.50	185	4
	0700-0800	1.40	1.40	.40	210	7
	0800-0900	1.40	1.40	.40	210	7.5
	0900-1000	1.40	1.40	.38	210	6.5
	1000-1100	1.40	1.40	.38	90	2.5
	1100-1200	1.40	1.40	.38	130	9.5
	1200-1300	1.40	1.40	.35	155	9
	1300-1400	1.40	1.40	.30	120	7
	1400-1500	1.40	1.40	.35	.55	4
	1500-1600	1.40	1.40	.33	190	8.5
	1600-1700	1.40	1.40	.35	160	14
	1700-1800	1.40	1.40	.43	275	11
	1800-1900	1.40	1.40	.30	270	9
	1900-2000	1.40	1.40	.31	300	6
	2000-2100	1.50	1.40	.40	315	4.5
	2100-2200	1.53	1.40	.50	280	3
	2200-2300	1.57	1.50	.50	265	5
	2300-2400	1.60	1.55	.50	240	2.5

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/17	0000-0100	1.55	1.50	.53	175	1.5
	0100-0200	1.58	1.58	.48	160	2.5
	0200-0300	1.58	1.55	.50	325	3
	0300-0400	1.80	1.64	.60	110	2.5
	0400-0500	1.80	1.80	.60	100	3
	0500-0600	1.73	1.62	.60	145	1.5
	0600-0700	1.70	1.60	.58	175	3
	0700-0800	1.50	1.50	.45	360	3
	0800-0900	1.44	1.44	.40	210	7
	0900-1000	1.40	1.40	.36	225	7
	1000-1100	1.40	1.40	.34	155	8
	1100-1200	1.40	1.40	.31	60	10
	1200-1300	1.42	1.40	.30	150	21
	1300-1400	1.43	1.40	.34	10	14
	1400-1500	1.57	1.40	.35	25	13.5
	1500-1600	1.50	1.40	.35	20	9.5
	1600-1700	1.40	1.40	.31	25	9.5
	1700-1800	1.45	1.40	.31	360	6
	1800-1900	1.40	1.40	.30	345	3
	1900-2000	1.40	1.40	.34	85	1
	2000-2100	1.40	1.40	.38	125	2
	2100-2200	1.43	1.43	.40	225	11
	2200-2300	1.42	1.42	.40	300	5
	2300-2400	1.45	1.45	.34	55	3
5/18	0000-0100	1.56	1.56	.44	185	2
	0100-0200	1.56	1.56	.40	275	4.5
	0200-0300	1.48	1.48	.40	35	2.5
	0300-0400	1.57	1.57	.39	145	1.5
	0400-0500	1.50	1.50	.40	255	2
	0500-0600	1.50	1.50	.37	165	1
	0600-0700	1.50	1.45	.37	300	2.5
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300	1.60	1.60	.50	290	6
	1300-1400	1.63	1.63	.50	200	5
	1400-1500	1.40	1.60	.48	330	5
	1500-1600	1.40	1.62	.48	30	5
	1600-1700	1.40	1.62	.47	305	5.5
	1700-1800	1.40	1.60	.47	120	2
	1800-1900	1.60	1.60	.47	330	2.5
	1900-2000	1.68	1.68	.48	315	3
	2000-2100	1.70	1.70	.50	180	5
	2100-2200	1.75	1.75	.55	120	1
	2200-2300	1.63	1.63	.50	185	5
	2300-2400	1.65	1.50	.52	330	1.5
5/19	0000-0100	1.62	1.62	.46	65	3
	0100-0200	1.70	1.70	.50	65	3.5
	0200-0300	1.65	1.65	.50	75	3
	0300-0400	1.60	1.60	.47	70	3.5
	0400-0500	1.60	1.60	.48	75	2.5
	0500-0600	1.60	1.60	.48	90	4
	0600-0700	1.60	1.60	.44	120	6
	0700-0800	1.70	1.70	.49	90	2.5
	0800-0900	1.62	1.62	.45	40	2
	0900-1000	1.60	1.60	.48	165	2.5
	1000-1100	1.60	1.60	.50	190	4.5
	1100-1200	1.60	1.60	.50	240	6
	1200-1300	1.60	1.60	.48	270	7
	1300-1400	1.61	1.61	.47	270	7
	1400-1500	1.60	1.60	.50	255	7
	1500-1600	1.60	1.60	.50	250	8
	1600-1700	1.60	1.60	.48	235	7
	1700-1800	1.60	1.60	.50	265	7
	1800-1900	1.60	1.60	.49	270	6
	1900-2000	1.60	1.60	.49	285	3.5
	2000-2100	1.63	1.63	.65	240	4
	2100-2200	1.70	1.70	.60	210	5.5
	2200-2300	1.60	1.60	.65	175	6
	2300-2400	1.60	1.60	.45	180	7.5
5/20	0000-0100	1.50	1.50	.45	140	6
	0100-0200	1.50	1.50	.47	120	7.5
	0200-0300	1.50	1.50	.45	120	8
	0300-0400	1.50	1.50	.43	115	6.5
	0400-0500	1.70	1.70	.48	120	7
	0500-0600	1.75	1.75	.44	90	8
	0600-0700	1.50	1.50	.42	110	9
	0700-0800	1.70	1.70	.43	140	10.5
	0800-0900	1.42	1.42	.40	150	11
	0900-1000	1.55	1.55	.40	130	18
	1000-1100	1.50	1.50	.40	180	21
	1100-1200	1.30	1.50	.40	185	24
	1200-1300	1.40	1.40	.40	180	25
	1300-1400	1.42	1.42	.40	195	23
	1400-1500	1.42	1.42	.45	195	24
	1500-1600	1.58	1.58	.45	210	23
	1600-1700	1.58	1.58	.44	210	24
	1700-1800	1.57	1.57	.42	210	23
	1800-1900	1.58	1.58	.43	205	19
	1900-2000	1.58	1.58	.47	195	15
	2000-2100	1.56	1.56	.43	195	16
	2100-2200	1.58	1.56	.42	195	14
	2200-2300	1.59	1.58	.45	210	11
	2300-2400	1.60	1.60	.44	200	7

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/21	0000-0100	1.59	1.59	.45	175	8
	0100-0200	1.58	1.58	.45	175	10
	0200-0300	1.59	1.59	.45	185	7
	0300-0400	1.58	1.58	.43	210	8.5
	0400-0500	1.60	1.60	.45	210	7.5
	0500-0600	1.60	1.60	.48	215	9.5
	0600-0700	1.60	1.60	.49	195	8.5
	0700-0800	1.60	1.60	.48	195	8
	0800-0900	1.60	1.60	.48	210	9
	0900-1000	1.60	1.60	.46	205	9
	1000-1100	1.60	1.60	.50	210	12
	1100-1200	1.60	1.63	.49	225	11
	1200-1300	1.60	1.60	.50	260	10
	1300-1400	1.60	1.60	.49	255	7
	1400-1500	1.60	1.60	.48	285	9
	1500-1600	1.59	1.59	.50	270	9
	1600-1700	1.58	1.58	.48	270	7
	1700-1800	1.59	1.59	.48	255	8
	1800-1900	1.60	1.60	.52	270	6
	1900-2000	1.58	1.58	.48	265	3
	2000-2100	1.60	1.60	.54	160	5
	2100-2200	1.80	1.80	.60	115	0
	2200-2300	1.70	1.70	.56	100	2.5
	2300-2400	1.68	1.68	.50	90	3
5/22	0000-0100	1.62	1.62	.53	90	3
	0100-0200	1.62	1.62	.50	90	3
	0200-0300	1.65	1.65	.50	120	3.5
	0300-0400	1.75	1.75	.53	90	3.5
	0400-0500	1.60	1.60	.52	70	3
	0500-0600	1.61	1.61	.50	65	3
	0600-0700	1.60	1.60	.50	95	1
	0700-0800	1.61	1.61	.50	120	5.5
	0800-0900	1.60	1.60	.50	150	3
	0900-1000	1.60	1.60	.53	195	2.5
	1000-1100	1.60	1.60	.50	265	5.5
	1100-1200	1.59	1.59	.50	240	8.5
	1200-1300	1.58	1.58	.50	240	7
	1300-1400	1.60	1.60	.50	270	8.5
	1400-1500	1.60	1.60	.48	270	10
	1500-1600	1.60	1.60	.49	265	9
	1600-1700	1.58	1.58	.48	270	7
	1700-1800	1.58	1.58	.48	270	7
	1800-1900	1.60	1.60	.50	240	3
	1900-2000	1.60	1.60	.50	185	3
	2000-2100	1.58	1.58	.55	135	2
	2100-2200	1.60	1.60	.60	115	2.5
	2200-2300	2.70	2.70	.65	105	2.5
	2300-2400	1.90	1.90	.50	75	4

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/23	0000-0100	1.59	1.59	.49	75	4
	0100-0200	1.59	1.59	.50	60	2
	0200-0300	1.58	1.58	.50	80	3
	0300-0400	1.59	1.59	.50	120	25
	0400-0500	1.63	1.63	.54	115	3
	0500-0600	1.70	1.62	.64	90	3
	0600-0700	1.61	1.61	.62	80	3
	0700-0800	1.60	1.60	.50	110	5.5
	0800-0900	1.60	1.60	.53	150	3.5
	0900-1000	1.60	1.60	.55	240	3
	1000-1100	1.58	1.58	.55	240	3
	1100-1200	1.55	1.55	.53	270	6.5
	1200-1300	1.58	1.58	.50	240	10
	1300-1400	1.56	1.56	.50	270	8
	1400-1500	1.58	1.58	.54	270	6.5
	1500-1600	1.59	1.59	.55	270	7.5
	1600-1700	1.60	1.60	.54	270	8.5
	1700-1800	1.58	1.58	.50	255	8
	1800-1900	1.59	1.59	.48	225	5
	1900-2000	1.60	1.60	.53	170	3.5
	2000-2100	1.63	1.63	.60	120	3.5
	2100-2200	1.80	1.80	.58	60	3.5
	2200-2300	1.59	1.59	.50	75	3.5
	2300-2400	1.58	1.58	.48	80	4
5/24	0000-0100	1.57	1.57	.50	90	4
	0100-0200	1.56	1.56	.50	90	2
	0200-0300	1.60	1.60	.54	100	5.5
	0300-0400	1.58	1.58	.50	80	4
	0400-0500	1.60	1.60	.55	105	5
	0500-0600	1.60	1.60	.53	105	6
	0600-0700	1.60	1.60	.50	90	6.5
	0700-0800	1.59	1.59	.51	115	7
	0800-0900	1.60	1.60	.50	120	7.5
	0900-1000	1.57	1.57	.49	145	5
	1000-1100	1.57	1.57	.49	205	4
	1100-1200	1.58	1.58	.50	235	4.5
	1200-1300	1.56	1.56	.48	240	6.5
	1300-1400	1.58	1.58	.48	270	8
	1400-1500	1.50	1.50	.48	300	5
	1500-1600	1.53	1.53	.46	270	8
	1600-1700	1.50	1.50	.49	255	6
	1700-1800	1.55	1.55	.48	255	5
	1800-1900	1.50	1.50	.47	300	3.5
	1900-2000	1.48	1.48	.50	220	5
	2000-2100	1.65	1.65	.60	110	2
	2100-2200	1.53	1.63	.52	85	3
	2200-2300	1.60	1.60	.50	85	3
	2300-2400	1.50	1.50	.50	80	3

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/25	0000-0100	1.58	1.58	.47	95	3.5
	0100-0200	1.59	1.59	.48	75	3.5
	0200-0300	1.50	1.50	.45	90	4
	0300-0400	1.53	1.53	.45	90	6
	0400-0500	1.59	1.59	.45	90	5
	0500-0600	1.58	1.58	.47	90	6
	0600-0700	1.57	1.57	.47	90	6
	0700-0800	1.58	1.58	.50	105	6.5
	0800-0900	1.57	1.57	.48	120	6
	0900-1000	1.53	1.53	.47	180	3.5
	1000-1100	1.55	1.55	.45	180	3
	1100-1200	1.55	1.55	.50	350	3
	1200-1300	1.56	1.56	.50	280	4
	1300-1400	1.55	1.55	.50	265	5
	1400-1500	1.50	1.50	.47	270	6.5
	1500-1600	1.50	1.50	.46	270	8.5
	1600-1700	1.49	1.49	.50	285	7
	1700-1800	1.56	1.56	.48	255	7
	1800-1900	1.59	1.59	.50	315	8.5
	1900-2000	1.57	1.57	.50	310	4
	2000-2100	1.60	1.60	.70	355	3
	2100-2200	1.57	1.57	.60	80	2
	2200-2300	1.58	1.59	.65	115	3
	2300-2400	1.60	1.60	.62	90	2.5
5/26	0000-0100	1.60	1.60	.60	105	3
	0100-0200	1.60	1.60	.53	105	1.5
	0200-0300	1.55	1.55	.49	75	4
	0300-0400	1.57	1.57	.48	90	5
	0400-0500	1.57	1.57	.50	95	7
	0500-0600	1.58	1.58	.51	95	6
	0600-0700	1.58	1.58	.50	90	6
	0700-0800	1.58	1.58	.45	90	6
	0800-0900	1.56	1.56	.45	120	6
	0900-1000	1.48	1.48	.42	135	3.5
	1000-1100	1.48	1.48	.43	185	3.5
	1100-1200	1.50	1.50	.48	210	4.5
	1200-1300					
	1300-1400	1.70	1.70	.53	240	5.5
	1400-1500	1.75	1.75	.54	265	5
	1500-1600	1.70	1.70	.51	270	8
	1600-1700	1.70	1.70	.55	300	8
	1700-1800	1.70	1.70	.53	240	5.5
	1800-1900	1.70	1.70	.50	300	4.5
	1900-2000	1.80	1.80	.50	330	3
	2000-2100	1.83	1.83	.63	300	3.5
	2100-2200	1.85	1.85	.75	80	2.5
	2200-2300	1.90	1.90	.80	150	3
	2300-2400	1.80	1.80	.55	115	1.5

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
5-27	0000-0100	1.85	1.85	.50	90	11
	0100-0200	1.83	1.83	.55		
	0200-0300	1.80	1.80	.50		
	0300-0400	1.80	1.80	.50		
	0400-0500	1.79	1.79	.50		
	0500-0600	1.75	1.75	.55		
	0600-0700	1.75	1.75	.50		
	0700-0800	1.77	1.77	.50		
	0800-0900	1.78	1.78	.50		
	0900-1000	1.75	1.75	.50		
	1000-1100	1.75	1.75	.68		
	1100-1200	1.68	1.68	.67		
	1200-1300	1.70	1.70	.67		
	1300-1400	1.70	1.70	.65		
	1400-1500	1.65	1.65	.50	210	11
	1500-1600	1.67	1.67	.50	230	11.5
	1600-1700	1.67	1.67	.50	240	11
	1700-1800	1.70	1.70	.50	250	11
	1800-1900	1.78	1.78	.50	250	8
	1900-2000	1.85	1.85	.60	220	4
	2000-2100	1.80	1.80	.60	150	2.5
	2100-2200	1.75	1.75	.50	115	6.5
	2200-2300	1.70	1.70	.50	210	10
	2300-2400	1.75	1.75	.48	205	8.5
5-28	0000-0100	1.70	1.70	.48	90	4
	0100-0200	1.70	1.70	.48	90	5
	0200-0300	1.70	1.70	.52	110	7.5
	0300-0400	1.70	1.70	.50	90	5
	0400-0500	1.70	1.70	.50	90	4
	0500-0600	1.75	1.75	.50	95	4
	0600-0700	1.75	1.75	.50	105	7
	0700-0800	1.70	1.70	.50	95	5
	0800-0900	1.75	1.75	.55	185	3
	0900-1000	1.77	1.77	.50	215	3
	1000-1100	1.77	1.77	.50	270	
	1100-1200	1.76	1.76	.55	285	7.5
	1200-1300	1.70	1.70	.58	270	8.5
	1300-1400	1.75	1.75	.58	265	11
	1400-1500	1.75	1.75	.50	270	9
	1500-1600	1.70	1.70	.52	270	9
	1600-1700	1.70	1.70	.53	255	9.5
	1700-1800	1.70	1.70	.55	240	8.5
	1800-1900	1.70	1.70	.50	240	11
	1900-2000	1.75	1.75	.50	210	7
	2000-2100	1.70	1.70	.53	195	5.5
	2100-2200	1.70	1.70	.50	210	6.5
	2200-2300	1.80	1.80	.50	220	7
	2300-2400	1.87	1.87	.70	255	2

DATE	TIME	THC	CH	CO	WIND DIRECTION	WIND SPEED
5/29	0000-0100	1.83	1.83	.75	180	2
	0100-0200	1.85	1.85	.83	150	1.5
	0200-0300	1.83	1.83	.60	150	3.5
	0300-0400	1.80	1.80	.55	50	2.5
	0400-0500	1.77	1.77	.55	180	2
	0500-0600	1.80	1.80	.70	100	4.5
	0600-0700	1.77	1.77	.55	100	3
	0700-0800	1.77	1.77	.50	90	3.5
	0800-0900	1.75	1.75	.50	90	1
	0900-1000	1.72	1.72	.50	60	3
	1000-1100	1.75	1.75	.52	180	7.5
	1100-1200	1.75	1.75	.50	210	8
	1200-1300	1.70	1.70	.50	290	6.5
	1300-1400	1.70	1.70	.50	360	11.5
	1400-1500	1.70	1.70	.50	360	10
	1500-1600	1.70	1.70	.50	10	7
	1600-1700	1.78	1.78	.50	340	4.5
	1700-1800	1.80	1.80	.60	15	6
	1800-1900	1.80	1.80	.58	75	7
	1900-2000	1.80	1.80	.55	55	5.5
	2000-2100	1.83	1.83	.60	75	6
	2100-2200	1.80	1.80	.60	75	8.5
	2200-2300	1.78	1.78	.55	75	7.5
	2300-2400	1.80	1.80	.60	80	5
5/30	0000-0100	1.80	1.80	.60	60	3
	0100-0200	1.80	1.80	.55	60	3
	0200-0300	1.80	1.80	.60	55	3
	0300-0400	1.80	1.80	.60	90	3
	0400-0500	2.00	2.00	.70	115	2.5
	0500-0600	1.97	1.07	.64	130	3
	0600-0700	1.84	1.84	.60	90	3.5
	0700-0800	1.83	1.83	.60	145	5
	0800-0900	1.82	1.82	.60	125	3
	0900-1000	1.83	1.83	.65	165	2.5
	1000-1100	1.80	1.80	.65	30	4
	1100-1200	1.82	1.82	.60	195	2/5
	1200-1300	1.82	1.82	.68	180	2
	1300-1400	1.80	1.80	.70	260	4
	1400-1500	1.83	1.83	.68	245	7
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
6-1	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800	1.70	1.70	1.00		
	1800-1900	1.70	1.70	.90		
	1900-2000	1.80	1.80	.85		
	2000-2100	1.90	1.90	.85		
	2100-2200	1.85	1.85	.78		
	2200-2300	1.85	1.85	.78		
	2300-2400	2.05	2.05	.70		
6-2	0000-0100	2.10	2.10	.93		
	0100-0200	1.95	1.95	.75		
	0200-0300	1.96	1.96	.80		
	0300-0400	1.95	1.95	.85		
	0400-0500	1.82	1.82	.60		
	0500-0600	1.83	1.83	.60		
	0600-0700	1.88	1.88	.65		
	0700-0800	1.82	1.82	.63		
	0800-0900	1.83	1.83	.63		
	0900-1000	1.83	1.83	.63		
	1000-1100	1.78	1.78	.65		
	1100-1200	1.73	1.73	.62		
	1200-1300	1.72	1.72	.62		
	1300-1400	1.65	1.65	.60		
	1400-1500	1.65	1.65	.60		
	1500-1600	1.85	1.85	.65		
	1600-1700	1.65	1.65	.60	220	6.5
	1700-1800	1.82	1.82	.60	230	13
	1800-1900	1.78	1.78	.65	240	10
	1900-2000	1.82	1.82	.70	270	8
	2000-2100	1.80	1.80	.75	325	2.5
	2100-2200	1.97	1.97	.85	360	2.5
	2200-2300	1.97	1.97	.80	100	3.5
	2300-2400	2.00	2.00	.85	100	4.5

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
6-3	0000-0100	1.98	1.98	.75	90	4
	0100-0200	2.00	2.00	.70	90	3.5
	0200-0300	1.90	1.90	.65	75	3.5
	0300-0400	1.80	1.80	.63	70	5
	0400-0500	1.80	1.80	.65	95	5
	0500-0600	1.80	1.80	.65	105	5.5
	0600-0700	1.90	1.90	.70	120	6.5
	0700-0800	1.90	1.90	.75	120	5
	0800-0900	1.88	1.88	.70	115	7.5
	0900-1000	1.80	1.80	.65	120	6
	1000-1100	1.70	1.70	.65	155	4.5
	1100-1200	1.65	1.65	.65	160	7
	1200-1300	1.68	1.68	.58	210	6
	1300-1400	1.70	1.70	.65	280	6
	1400-1500	1.70	1.70	.63	310	6.5
	1500-1600	1.60	1.60	.58	230	7.5
	1600-1700	1.65	1.65	.60	240	12
	1700-1800	1.75	1.75	.65	300	14
	1800-1900	1.70	1.70	.70	300	11
	1900-2000	1.85	1.85	.70	305	5
	2000-2100	2.10	2.10	.75	305	4
	2100-2200	2.00	2.00	*1.00(1.70)	255	3
	2200-2300	2.05	2.05	*1.25(1.60)	175	1.5
	2300-2400	2.10	2.10	1.05	90	3
6-4	0000-0100	2.00	2.00	1.00	90	3
	0100-0200	1.80	1.80	.85	125	4
	0200-0300	1.95	1.95	.60	135	4.5
	0300-0400	2.05	2.05	.70	120	5
	0400-0500	1.95	1.95	.65	85	3
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					

* (= Peak value during hour.)

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
6-9	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200	1.55	1.55	.24	210	4.5
	2200-2300	1.60	1.60	.20	205	4.5
	2300-2400	1.58	1.58	.23	270	3.5
6-10	0000-0100	1.62	1.62	.18	25	3
	0100-0200	1.62	1.62	.18	135	5
	0200-0300	1.79	1.79	.22	100	5
	0300-0400	1.63	1.63	.18	90	5
	0400-0500	1.63	1.63	.18	90	5
	0500-0600	1.61	1.61	.17	90	6
	0600-0700	1.62	1.62	.17	90	5
	0700-0800	1.68	1.68	.16	110	7
	0800-0900	1.64	1.64	.17	180	4
	0200-1000	1.60	1.60	.18	270	4
	1000-1100	1.59	1.59	.17	255	6
	1100-1200	1.58	1.58	.17	270	10
	1200-1300	1.57	1.57	.19	270	7
	1300-1400	1.55	1.55	.20	275	8.5
	1400-1500	1.50	1.50	.18	270	10.5
	1500-1600	1.44	1.44	.17	255	10
	1600-1700	1.46	1.46	.17	250	11
	1700-1800	1.48	1.48	.19	235	12
	1800-1900	1.56	1.56	.18	230	10
	1900-2000	1.65	1.65	.20	210	8
	2000-2100	1.60	1.60	.24	215	6.5
	2100-2200	1.60	1.60	.24	220	6
	2200-2300	1.70	1.70	.26	245	4
	2300-2400	1.90	1.90	.40	125	3

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
8-11	0000-0100	1.80	1.80	.33	130	1
	0100-0200	1.80	1.80	.32	120	1.5
	0200-0300	1.76	1.76	.30	85	3
	0300-0400	1.68	1.68	.32	240	2.5
	0400-0500	1.66	1.66	.45	90	1.5
	0500-0600	1.63	1.63	.28	30	2
	0600-0700	1.68	1.68	.30	350	2
	0700-0800	1.71	1.71	.24	290	3
	0800-0900	1.62	1.62	.29	250	3.5
	0900-1000	1.58	1.58	.23	225	3.5
	1000-1100	1.48	1.48	.19	210	3
	1100-1200	1.43	1.43	.18	180	4
	1200-1300	1.43	1.43	.19	180	6
	1300-1400	1.41	1.41	.19	285	7
	1400-1500	1.41	1.41	.17	240	7
	1500-1600	1.40	1.40	.17	270	8
	1600-1700	1.40	1.40	.18	300	6.5
	1700-1800	1.40	1.40	.30	300	6.5
	1800-1900	1.48	1.48	.36	315	5
	1900-2000	1.69	1.69	.47	340	2
	2000-2100	1.68	1.68	.52	45	2
	2100-2200	1.68	1.68	.51	90	3.5
	2200-2300	1.66	1.66	.49	100	3.5
	2300-2400	1.60	1.60	.40	95	4
8-12	0000-0100	1.60	1.60	.40	105	4
	0100-0200	1.60	1.60	.26	100	5
	0200-0300	1.65	1.65	.31	130	4
	0300-0400	1.74	1.74	.40	120	4.5
	0400-0500	1.70	1.70	.28	90	3.5
	0500-0600	1.60	1.60	.24	100	4
	0600-0700	1.60	1.60	.25	110	5
	0700-0800	1.70	1.70	.31	150	4.5
	0800-0900	1.61	1.61	.33	60	2
	0900-1000	1.50	1.50	.40	315	3.5
	1000-1100	1.44	1.44	.35	270	4
	1100-1200	1.42	1.42	.40	250	4
	1200-1300	1.40	1.40	.20	270	6.5
	1300-1400	1.35	1.35	.17	270	4.5
	1400-1500	1.31	1.31	.16	285	6
	1500-1600	1.32	1.32	.16	270	8.5
	1600-1700	1.32	1.32	.18	300	8
	1700-1800	1.35	1.35	.19	325	8
	1800-1900	1.41	1.41	.30	315	8
	1900-2000	1.57	1.57	.35	320	7.5
	2000-2100	1.61	1.61	.49	360	3.5
	2100-2200	1.60	1.60	.43	55	4
	2200-2300	1.60	1.60	.42	135	2
	2300-2400	1.70	1.70	.52	195	1.5

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
8-13	0000-0100	1.72	1.72	.44	210	2
	0100-0200	1.60	1.60	.27	150	3
	0200-0300	1.60	1.60	.30	75	4.5
	0300-0400	1.63	1.63	.30	105	5
	0400-0500	1.62	1.62	.30	90	5
	0500-0600	1.60	1.60	.23	90	4.5
	0600-0700	1.60	1.60	.22	90	7
	0700-0800	1.62	1.62	.21	90	6.5
	0800-0900	1.54	1.54	.18	75	5
	0900-1000	1.44	1.44	.17	60	4
	1000-1100	1.40	1.40	.17	50	4
	1100-1200	1.38	1.38	.16	335	3.5
	1200-1300	1.36	1.36	.18	180	5
	1300-1400	1.38	1.38	.21	260	6.5
	1400-1500	1.70	1.70	.24	270	5.5
	1500-1600	1.60	1.60	.23	270	7
	1600-1700	1.32	1.32	.17	245	6.5
	1700-1800	1.30	1.30	.18	275	6.5
	1800-1900	1.39	1.39	.22	270	4.5
	1900-2000	1.48	1.48	.22	330	3
	2000-2100	1.57	1.57	.44	335	2
	2100-2200	1.60	1.60	.67	30	3
	2200-2300	1.70	1.70	.50	120	2
	2300-2400	2.60	2.60	.80	135	4
8-14	0000-0100	2.10	2.10	.75	45	1.5
	0100-0200	1.80	1.80	.75	30	2.5
	0200-0300	1.60	1.60	.38	40	4
	0300-0400	1.77	1.77	.55	100	4.5
	0400-0500	1.70	1.70	.35	100	5
	0500-0600	1.65	1.65	.30	100	4.5
	0600-0700	1.70	1.70	.30	120	5.5
	0700-0800	1.70	1.70	.28	100	5.5
	0800-0900	1.55	1.55	.18	115	5
	0900-1000	1.43	1.43	.18	100	4
	1000-1100	1.40	1.40	.18	200	5
	1100-1200	1.37	1.37	.17	240	5.5
	1200-1300	1.32	1.32	.13	270	7
	1300-1400	1.28	1.28	.12	270	7
	1400-1500	1.28	1.28	.13	270	7
	1500-1600	1.23	1.23	.12	295	6
	1600-1700	1.22	1.22	.12	300	7
	1700-1800	1.22	1.22	.12	315	7
	1800-1900	1.35	1.35	.29	300	7
	1900-2000	1.44	1.44	.48	300	5
	2000-2100	1.60	1.60	.70	300	3
	2100-2200	1.75	1.75	.80	30	2
	2200-2300	1.50	1.50	.77	95	3
	2300-2400	1.57	1.57	.88	90	3.5

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
6-15	0000-0100	1.70	1.70	.38	105	4
	0100-0200	1.60	1.60	.24	110	6
	0200-0300	1.60	1.60	.20	105	5.5
	0300-0400	1.55	1.55	.19	90	6
	0400-0500	1.55	1.55	.17	90	6
	0500-0600	1.51	1.51	.17	105	5
	0600-0700	1.55	1.55	.18	105	7
	0700-0800	1.58	1.58	.18	120	9
	0800-0900	1.54	1.54	.18	120	4.5
	0900-1000	1.41	1.41	.18	140	2.5
	1000-1100	1.38	1.38	.18	180	4
	1100-1200	1.32	1.32	.16	210	5
	1200-1300	1.28	1.28	.16	255	7
	1300-1400	1.28	1.28	.14	270	8
	1400-1500	1.27	1.27	.15	270	10
	1500-1600	1.24	1.24	.14	270	8
	1600-1700	1.27	1.27	.17	270	8.5
	1700-1800	1.25	1.25	.17	270	8
	1800-1900	1.30	1.30	.20	280	4
	1900-2000	1.50	1.50	.26	230	3
	2000-2100	1.62	1.62	.32	155	3
	2100-2200	1.60	1.60	.30	120	3
	2200-2300	1.60	1.60	.29	50	2
	2300-2400	1.56	1.56	.30	90	1.5
6-16	0000-0100	1.37	1.48	.22	345	2.5
	0100-0200	1.50	1.50	.23	90	4
	0200-0300	1.57	1.57	.22	75	6
	0300-0400	1.50	1.50	.20	90	5
	0400-0500	1.50	1.50	.20	115	7
	0500-0600	1.50	1.50	.20	110	7
	0600-0700	1.52	1.52	.21	115	8
	0700-0800	1.57	1.57	.20	120	9
	0800-0900	1.50	1.50	.20	110	5.5
	0900-1000	1.40	1.40	.20	150	4
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100					
	2100-2200					
	2200-2300					
	2300-2400					

Date	Time	THC	CH	CO	Wind Direction	Wind Speed
6-17	0000-0100					
	0100-0200					
	0200-0300					
	0300-0400					
	0400-0500					
	0500-0600					
	0600-0700					
	0700-0800					
	0800-0900					
	0900-1000					
	1000-1100					
	1100-1200					
	1200-1300					
	1300-1400					
	1400-1500					
	1500-1600					
	1600-1700					
	1700-1800					
	1800-1900					
	1900-2000					
	2000-2100	1.36	1.56	1.30	200	11.5
	2100-2200	1.60	1.60	1.25	195	18
	2200-2300	1.56	1.56	.90	185	15
	2300-2400	1.58	1.58	.65	175	14.5
6-18	0000-0100	1.55	1.55	.60	180	12
	0100-0200	1.52	1.52	.60	195	10
	0200-0300	1.52	1.52	.33	195	9
	0300-0400	1.53	1.53	.30	195	9
	0400-0500	1.54	1.54	.27	210	12
	0500-0600	1.56	1.56	.24	210	10
	0600-0700	1.57	1.57	.23	205	13
	0700-0800	1.55	1.55	.22	210	20
	0800-0900	1.57	1.57	.22	240	14
	0900-1000	1.57	1.57	.10	240	13
	1000-1100	1.53	1.53	.20	240	11.5
	1100-1200	1.50	1.50	.19	240	11.5
	1200-1300	1.50	1.50	.18	240	11
	1300-1400	1.49	1.49	.18		
	1400-1500	1.49	1.49	.18		
	1500-1600	1.48	1.48	.17		
	1600-1700	1.33	1.48	.18	235	17
	1700-1800	1.47	1.47	.18	240	13.5
	1800-1900	1.40	1.40	.15	240	13.5
	1900-2000	1.48	1.48	.15	240	7.5
	2[illegible]0-2100	1.47	1.47	.20	300	4
	2100-2200	1.55	1.55	.28	220	0
	2200-2300	1.59	1.59	.28	150	5
	2300-2400	1.46	1.46	.17	180	4

The method of estimating the horizontal Gaussian dispersion parameters (σ_y) from wind records was taken from a September 28, 1970, EPA course discussion entitled, "Diffusion of Air Pollution - Theory and Application." The process of this analysis was to compute qualitative horizontal dispersion

coefficients, σ_y, as a function of downwind distance, x, from a monitoring site so that the stability class could be determined and then compared with the Pasquill classes subjectively derived from surface weather observations. The formula used to calculate σ_y was:

$$\sigma_y = \sigma_\theta x \qquad \text{(Eq. 1)}$$

where:

$$\sigma_\theta = \sqrt{\frac{\Sigma(\theta_i - \theta)^2}{n - 1}}$$

and:

$$x = \beta u s$$

and:

μ = WS
x = Downwind distance from sensor
σ = SD of wind direction R
θ = Azimuth angle of the wind
s = Averaging time for each increment
n = Number of averaging time periods per measurement period
β = Ratio of the Lagrangian to Eulerian time scales (approx. 4)
y = Lateral direction normal to VMWD.

The total extreme WD difference, $\Delta\theta$, within the $_i$ averaging time was also measured on the charts and averaged for the experiment period. This was intended as an additional indication of the spread of small-scale turbulence. Table B-1 summarizes all the wind dispersion calculations made. The values of average wind azimuth angle, θ, are approximate since more precise measurements were not conducted. Figures B-1 through B-5 are plots of the calculated σ_y versus x on graphs that also indicate the six Pasquill stability classes (A to C are unstable, D is neutral, E and F are stable).

Calculations were performed with the strip-chart data from Periods 2 to 5 using a 5-minute averaging time (Table B-1) to test whether or not turbulence at all the trailers was similar (σ_y and x were determined at several trailers using the same averaging time to extract θ during the same period). In the nighttime case, period 2, the values of σ_y were similar except for station 4 (Figure B-1). In the daytime case, period 5, all values of the dispersion coefficient were sufficiently close to assume that similar turbulence took place at all trailers (Figure B-2). Some of the charts showed

TABLE B-1. WIND DISPERSION STUDY RESULTS, WAFB, JUNE 1976

Run ID		Instrument: R.M. Young Co. Gill Propeller Vane											
Trailer	Run	Date	Start Time	Stop Time	Averaging Time (min)	# Time Increments for Period	(magnetic north = 0°) $\bar{\theta}$ (degrees)	σ_θ (degrees)	$\bar{u}$ (m/sec)	$x=\beta u s$, $\beta=4$ x (km)	$\sigma_y=\sigma_\theta x$ σ_y (m)	$\overline{\Delta\theta}$ (degrees)	$\sigma_{\overline{\Delta\theta}}$ (degrees)
1	1	4 Jun	0900	1545	5	78	179	63	2.8	3.4	3740	120	57
1	2	4-5 Jun	2205	0320	5	60	77	27	1.8	2.2	1040	25	17
2	2	4-5 Jun	2205	0320	5	60	120	31	2.1	2.5	1340		-
4	2	4-5 Jun	2205	0320	5	60	115	40	1.1	1.4	950		-
1	3	5 Jun	0320	0740	5	52	84	6	2.0	2.4	260	28	12
1	4	5 Jun	0805	1600	5	97	243	33	3.2	3.8	2190	82	25
1	4	5 Jun	1000	1300	1.25	144	253	24	3.2	1.0	409	54	17
3	4	5 Jun	1000	1400	2.5	96	273	20	3.5	2.1	725	81	27
1	5	6 Jun	1400	1720	5	40	233	14	5.2	6.2	1550	77	35
2	5	6 Jun	1400	1720	5	40	259	15	5.8	7.0	1850	57	27
3	5	6 Jun	1400	1720	5	36	273	18	3.6	4.3	1340	83	31
4	5	6 Jun	1400	1720	5	40	255	17	5.4	6.5	1900	80	37
2	6	7 Jun	0300	0720	2.5	104	92	31	3.0	1.8	973	25	13
4	6	7 Jun	0300	0720	5	52	90	28	2.9	3.5	1710	25	15
5	6	7 Jun	0300	0720	7.5	34	44	24	3.7	6.6	2770	33	15
1	7	7 Jun	1100	1400	2.5	80	167	28	5.5	3.3	1610	63	17
2	7	7 Jun	1100	1700	5	72	213	38	6.0	7.2	4810	70	15
4	7	7 Jun	1100	1700	7.5	48	214	44	5.8	10.5	8030	87	33
1	3	5 Jun	0320	0740	5	52	84	6	2.0	2.4	260	28	12
2	3	5 Jun	0320	0740	15	17	104	10	3.8	13.7	2400	29	8
4	3	5 Jun	0320	0740	10	26	115	10	2.5	6.1	1070	63	19
5	3	5 Jun	0320	0740	7.5	34	62	13	4.4	8.5	1940	24	11

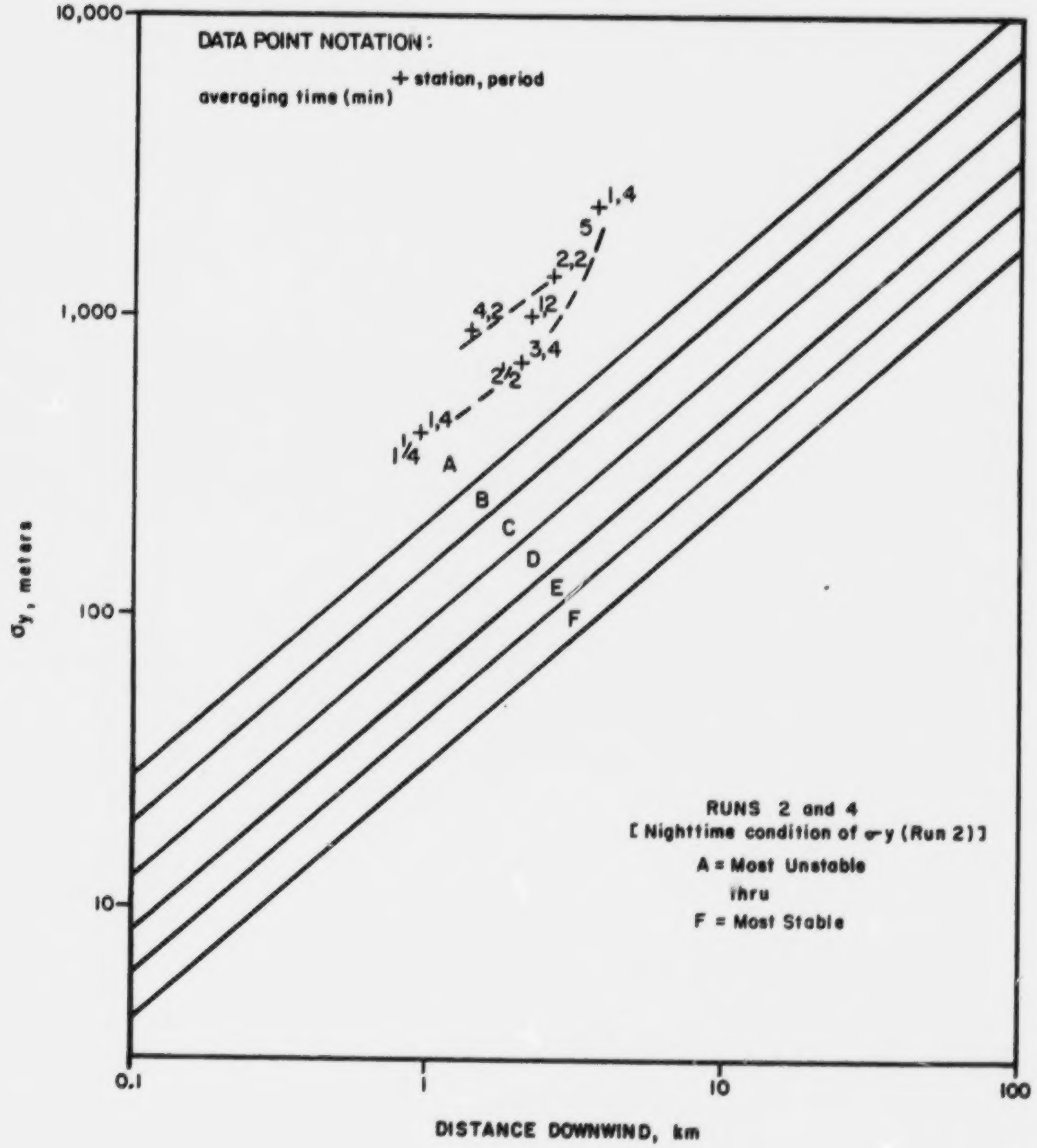

Figure B-1. Horizontal dispersion coefficient as a function of downwind distance from the source, runs 2 and 4.

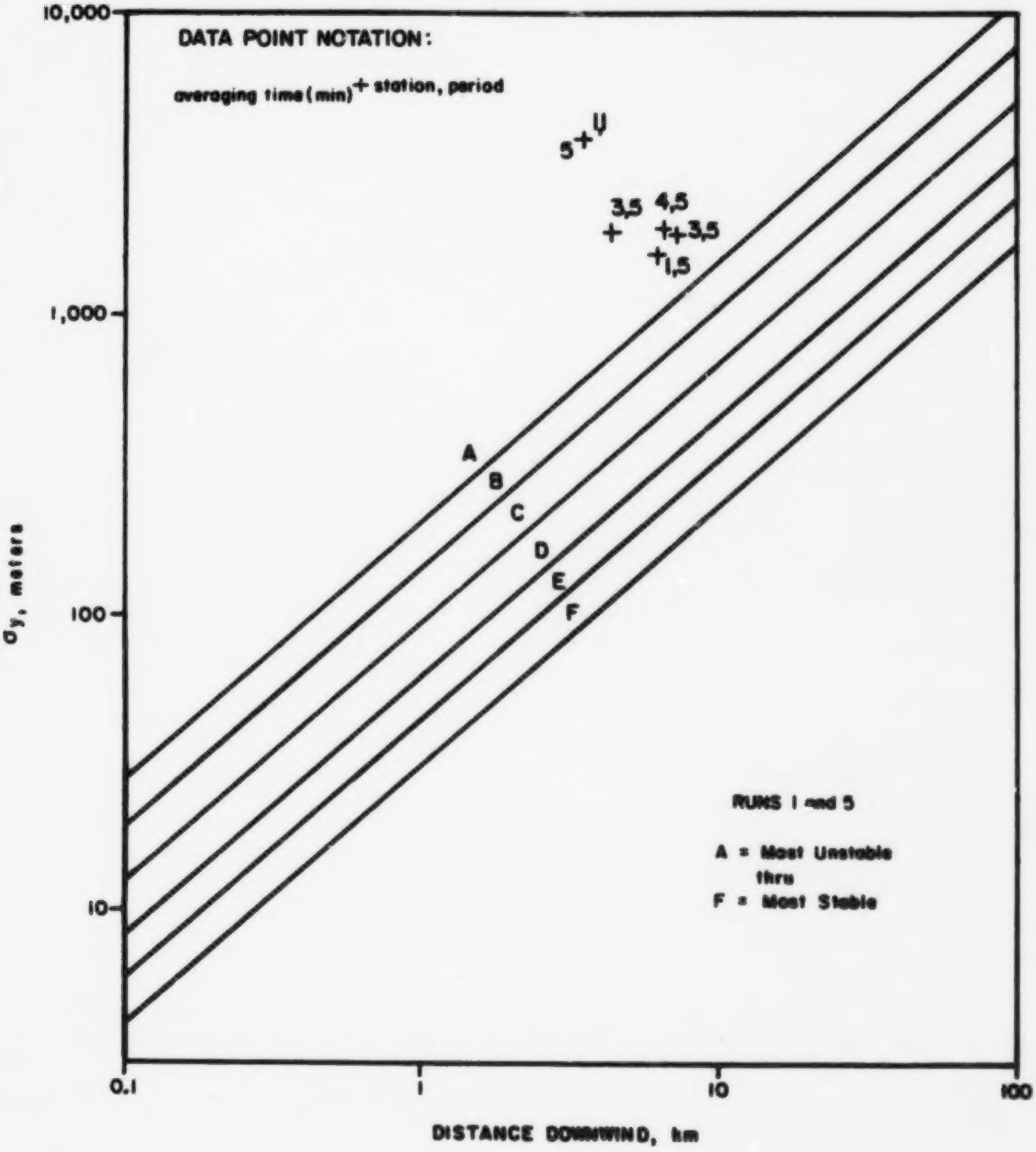

Figure B-2. Horizontal dispersion coefficient as a function of downwind distance from the source, runs 1 and 5.

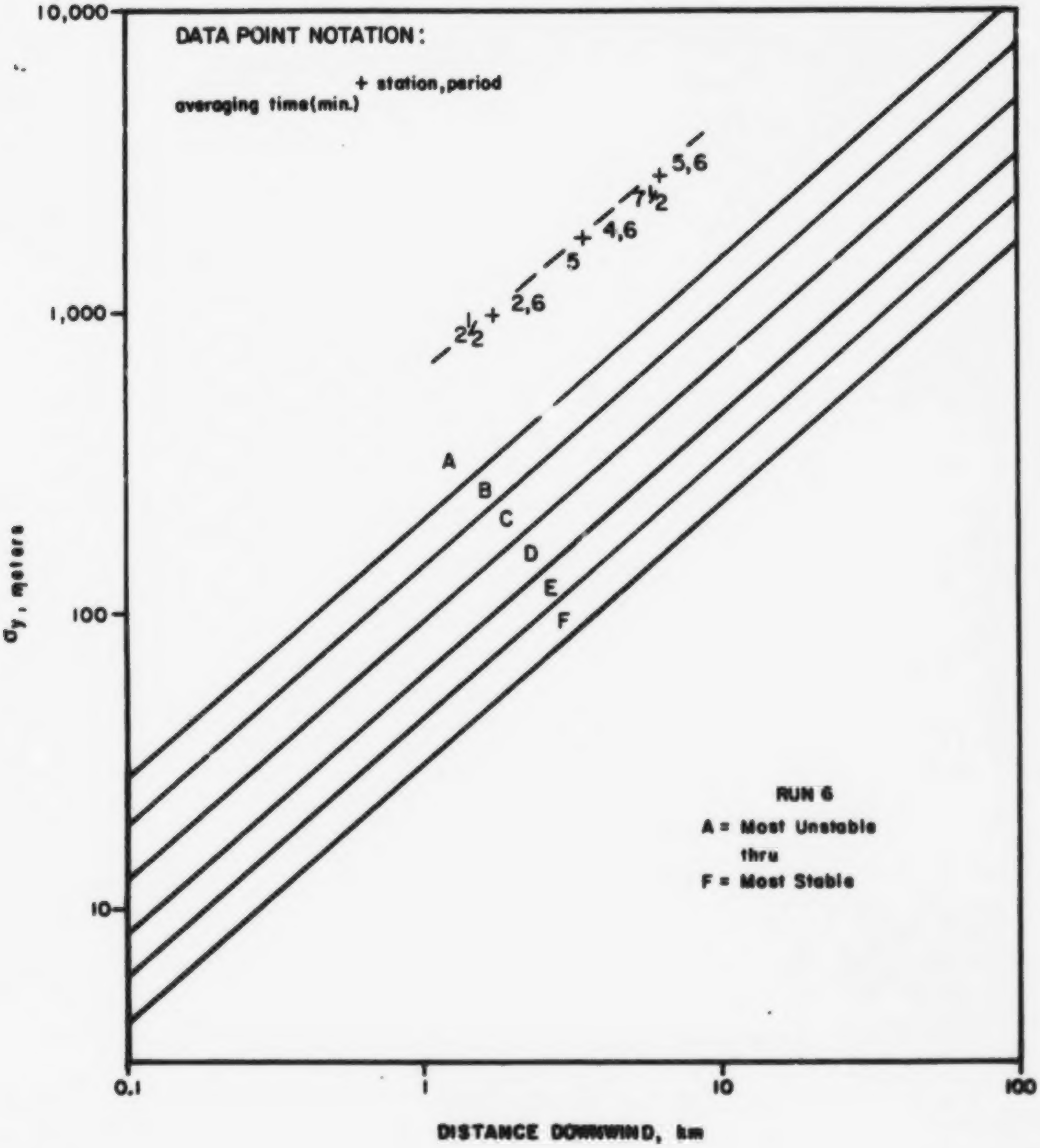

Figure B-3. Horizontal dispersion coefficient as a function of downwind distance from the source, run 6.

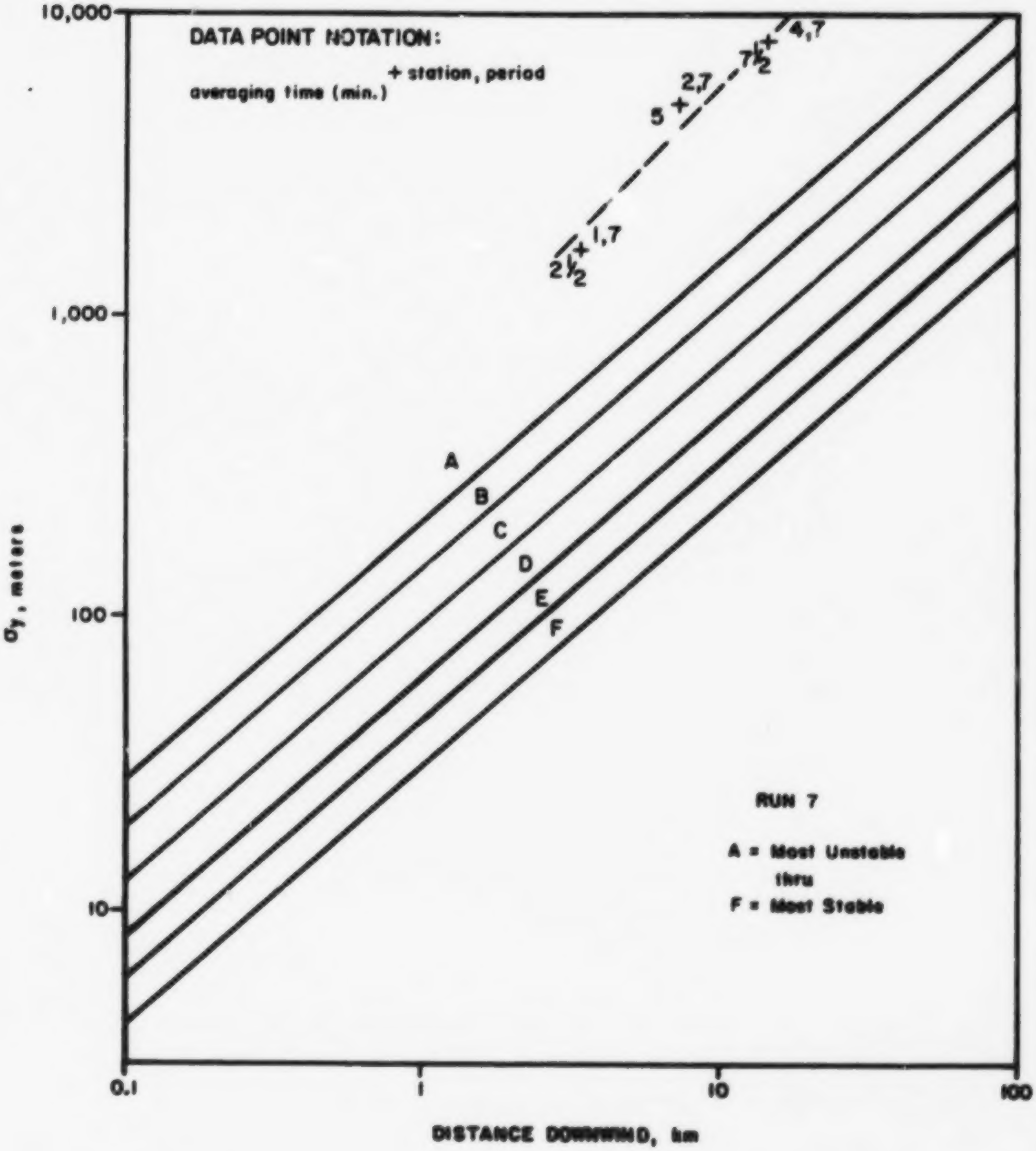

Figure B-4. Horizontal dispersion coefficient as a function of downwind distance from the source, run 7.

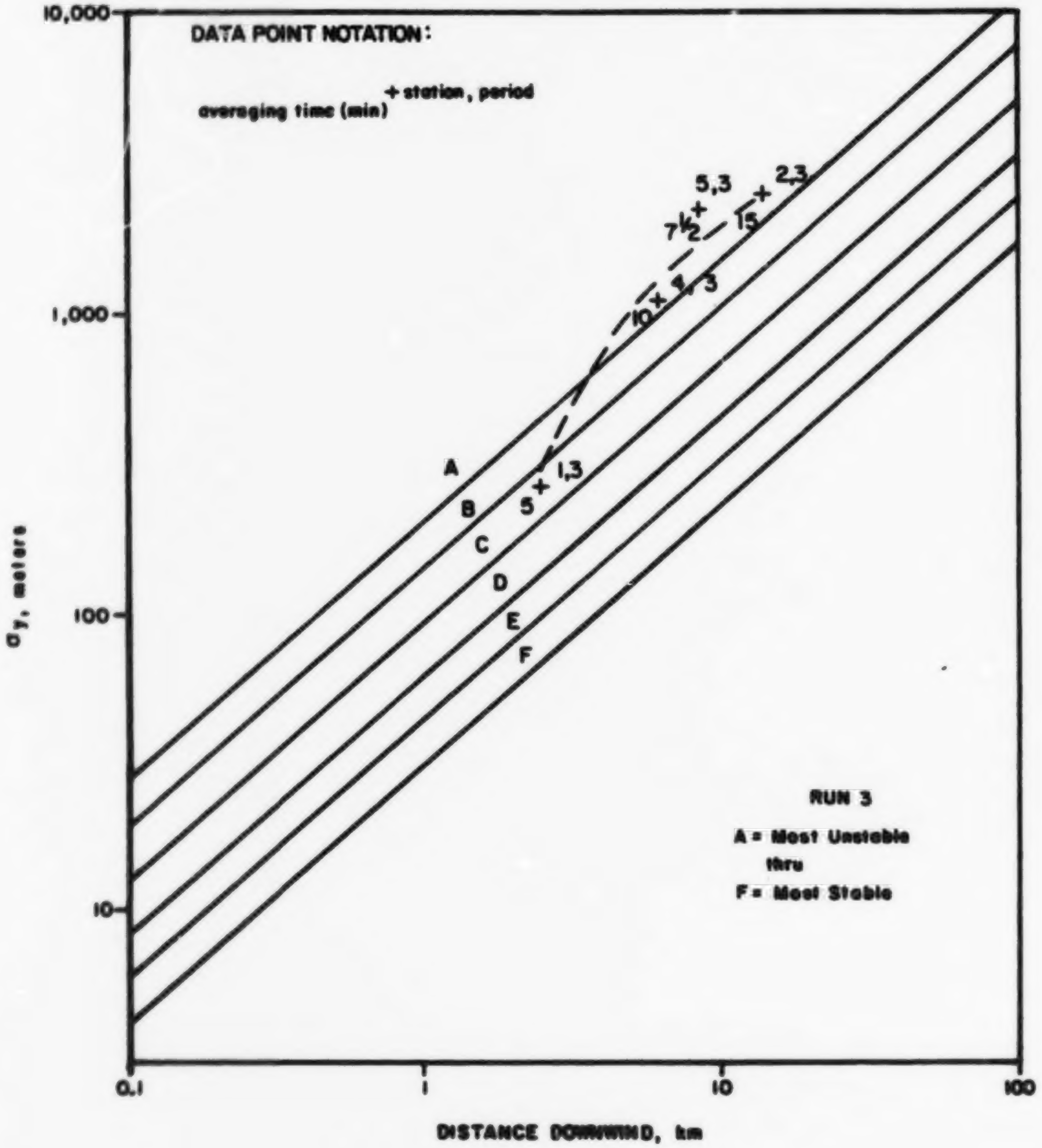

Figure B-5. Horizontal dispersion coefficient as a function of downwind distance from the source, run 3.

larger small-scale change in direction at station 4, but since this was smaller than most averaging times, the stability calculations were not affected. For example, notice the $\Delta\theta$ (total span of WD difference during period) values for runs 3, 5, and 7 at station 4 in Table B-1.

The remaining sets of calculations were performed to determine the effect of different downwind distances on stability class. Different averaging times were used to calculate σ_y and x in runs 3, 4, 6 and 7. Run 4 indicates that between 1-1/4 and 5-minute averaging times, the stability classes are about the same. If in fact the stability classes are the same for different averaging times, then the assumptions of the derivation and method are supported. The results are better for runs 6 and 7. Note in Figures B-3 and B-4 that the σ_y values almost exactly parallel the Pasquill lines. Although period 6 was in the early morning, it still shows that a Pasquill Class A would be insufficient to describe the magnitude of instability at WAFB. For the daytime case, period 7, the magnitude of instability that occurred over the hot WAFB runways exceeded Class A. Longer averaging times were used to calculate the diffusion coefficient in run 3. This early morning period (Class F by subjective classification) was the most stable of the four study days. Even so, this most stable period compared to a Class C.

A comparison of the average total variation of direction within the averaging time gives an indication of the turbulence intensity at small wavelengths. In the early morning hours, period 6 for example, $\Delta\theta$ was 15° to 30°, whereas during the day the values were usually more than twice that. The nighttime fluctuations were usually more frequent because of mechanical turbulence, but the daytime small-scale fluctuations were larger as a result of thermal turbulence.

In conclusion, because of the intense insolation in the Phoenix valley, the lower atmosphere remains from slightly unstable to extremely unstable throughout the day and into the night during the summer. Pasquill stability classes seem to be low by an average of two classes. The most unstable case, Class A, is off by a factor of 2 or 3.

PARTICLE MORPHOLOGY OF AEROSOLS COLLECTED AT WAFB

In November 1975, the EPA (with the assistance of the Illinois Institute of Technology Research Institute [IITRI] as a contractor) conducted an experimental program in the Phoenix metropolitan area to measure the mass flux and to identify aerosols entering and leaving Phoenix. Data obtained were to be used by the EPA to develop control strategies for air quality control regions in the southwestern United States. In conjunction with the Phoenix study, the EPA requested that aerosol samples be collected at WAFB to determine the impact of the base on local air quality. Microscopic examination of the collected aerosols was conducted to determine what differences, if any, existed between particle types collected at WAFB and those collected in the Phoenix metropolitan area.

Aerosol samples were collected on November 17, 18, 21, 23-24 (overnight), and 25, 1975, with four samplers located at three different sites at WAFB:

near site 4 at Building 16; at a remote sensing unit near site 2; and at a transmitter antenna near site 1 that had samplers situated at 1.55 m and 4.5 m AGL. Sampling intervals were chosen to take advantage of windflow patterns in the Phoenix valley area. Battelle five-stage fractionating samplers were used. Stage collection plates were 2.54-cm-diameter glass discs, and a 0.4-μm pore-size nucleopore filter was used as a backup filter. The first two glass disc stages were coated with Apiezon grease to minimize bounce off of the larger particles; the final three stages were uncoated. At a flow rate of 0.05 liter/m, assuming uniform density, cut sizes for the five stages were 4 μm, 1 μm, 0.5 μm, and 0.25 μm. Table B-2 lists sampler identifications and actual count of particles on each stage.

Microscopic Analysis

All samples collected at WAFB were submitted to the Fine Particles Research Section of IITRI for microscopic examination. All Glass-disc collection substrates were examined by optical microscopy, and some were further examined by scanning electron microscopy. Selected nucleopore filters were also examined by scanning electrion microscopy. The first two stages were coated with Apiezon grease, which has a crystalline structure that interferes with the identification of aerosols by polarized light microscopy. Samples were prepared by warming them to melt the grease and to remove this interference; some particles are lost in this process. General observations made during the examination of each sample are given in an IITRI report.

The particle size distribution data indicate that, on a number basis, the mean particle diameter at each sampling site was less than 2 millimeters (mm). Any sulfate particles lost during particle removal from the substrates would also have fallen into this size category [26, 27]. In addition to categorization by size, the particles were also categorized into two basic types -- mineral and nonmineral. The mineral category contained various soil minerals, fly ash spheres, and higher density particles such as metal fragments. The nonmineral category included the fine carbonaceous particles, carbonized flakes, biological particles, and tire rubber particulate. Size distribution data obtained are presented in Tables B-3 and B-4.

Summary of Results

The primary components of atmospheric aerosols in terms of mass at WAFB are minerals indigenous to the soil of the area. Motor vehicle traffic was partially responsible for resuspension of the soil minerals. Analysis in the size ranges shown indicates that the vehicles themselves contributed only minor concentrations of particulates to the atmosphere.

The major differences between WAFB and Phoenix aerosols were concentrations of clay aggregates and clay-coated minerals and higher (ammonium) sulfate concentrations at WAFB. The mineral concentrations were probably because there are fewer paved roadways and shoulders around WAFB compared to the Phoenix metropolitan area (i.e., surrounding agricultural land use). The greater sulfate concentrations were the result, at least in part, of the closer proximity of WAFB to large smelter plants. This conclusion was supported by the presence of copper-sulfur, lead-bismuth, and tin species on

TABLE B-2. WAFB AEROSOL SAMPLER IDENTIFICATION AND DATA

Date	Site	Time	Sampler No	Substrate 1	2	3	4	5	Backup
17 Nov 75	Transm. 5'	1220 - 1820	D	48	47	2046	2045	2044	3
	Transm. 15'	1220 - 1820	E	49	50	2053	2054	2055	4
	Bldg. 16	1140 - 1735	1003	16	15	2012	2011	2010	1
	Remote unit	1110 - 1710	1004	46	45	2043	2042	2041	2
18 Nov 75	Transm. 5'	1105 - ?	D	55	56	2058	2057	2056	5
	Transm. 15'	1105 - ?	E	57	58	2065	2066	2067	6
	Bldg. 16	1040 - 1710	1003	51	53	2059	2060	206	8
	Remote unit	1055 - 1735	1004	54	59	2062	2063	2064	7
21 Nov 75	Transm. 5'	--	1001 (control)	70	69	2082	2081	2080	-
	Transm. 5'	0545 - 1545	D	112	113	2148	2149	2150	13
	Transm. 15'	0545 - 1545	E	114	115	2151	2111	2112	15
	Bldg. 16	--	1006 (control)	68	67	2079	2078	2077	-
	Bldg. 16	0505 - 1505	1003	111	110	2147	2146	2110	16
	Remote unit	0530 - 1530	1004	108	109	2109	2108	2107	14
23-24 Nov	Transm. 5'	2110 - 0720	D	119	130	2141	2140	2139	12
	Transm. 15'	2110 - 0720	E	137	136	2144	2143	2142	10
	Bldg. 16	2125 - 0730	1003	132	131	2132	2131	2145	9
	Remote unit	2055 - 0710	1004	135	134	2138	2137	2136	11
25 Nov 75	Transm. 5'	0650 - 1540	E	151	156				18
	Transm. 15'	0650 - 1540	D	159	157				19
	Bldg. 16	0700 - 1555	1004	160	161				22
	Remote unit	0640 - 1530	1003	162	158				21

TABLE B-3. TOTAL PARTICLE SIZE DISTRIBUTIONS

Sample Site	<2 µm	2-8 µm	8-20 µm	20-40 µm	<40 µm	Total
5 ft Transmitter	836	248	122	27	6	1239
Building 16	761	245	147	42	12	1207
Remote unit	552	255	133	34	14	988
			Number Percentage			
5 ft Transmitter	67.5	20.0	9.8	2.2	.5	100
Building 16	16.0	20.3	12.2	3.5	1.0	100
Remote unit	55.9	25.8	13.5	3.4	1.4	100

TABLE B-4. PARTICLE SIZE DISTRIBUTIONS ACCORDING TO PARTICLE TYPE

Sample Site	<2 µm		2-8 µm		8-20 µm		20-40 µm		>40 µm		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
					Mineral							
5 ft Transmitter	330	56.0	150	25.5	84	14.2	21	3.6	4	.7	589	100
Building 16	305	50.5	161	26.6	100	16.5	31	5.1	8	1.3	605	100
Remote unit	201	39.2	175	34.0	101	19.7	27	5.3	9	1.8	513	100
					Nonmineral							
5 ft Transmitter	506	77.8	98	15.2	38	5.8	6	.9	2	.3	650	100
Building 16	456	75.7	84	14.0	47	7.8	11	1.8	4	.7	602	100
Remote unit	351	73.9	80	16.8	32	6.7	7	1.5	5	1.1	475	100

the small particle size stages of the impactor collectors. Significant numbers of particles in the light-scattering size range were present at all sites on all dates. The majority of the particles in the light-scattering range were mineral particles and liquid containing sulfate droplets. A complete report on this Williams aerosol study is in the IITRI report [18] and in a subsequent EPA publication.

Assuming an average size distribution that remained constant over the monitoring period, it is possible to infer a particle mass loading (for an average WAFB atmosphere) from b_{scat} measurements. Unfortunately, the greatest variability was shown in the less-than-2-μm-diameter size range in this study for a short period of time. Details of this correlation have been presented by Tombach and Charlson [19, 28] who state that particulate size distribution and specific gravity, remaining constant with time, can have the following approximate proportionality:

$$m(g/m)^3 = .45^{+.45}_{-.22} \cdot \beta(m^{-1}) \qquad \text{(Eq. 2)}$$

where β is the scattering at wavelengths visible to the human eye.

REMOTE OPTICAL SENSING OF EMISSIONS STUDY

Long-path infrared spectroscopic measurements of CO concentrations were made during the period February 10 through 19, 1976, at WAFB. These measurements provided integrated CO concentrations over the path length between two points for the measurement. They were included as a part of the program because of the inherent difficulty of comparing the average value predictions of dispersion models with the fixed-point values obtained from conventional sampling stations. This instrumentation provides path-averaged concentrations for more direct comparison to models. This section describes the experimental procedures used and presents the results of the measurements. Complete details of the experiment are available in an EPA letter report by Dr. William Herget [29].

The long-path measurements were carried out using the ROSE system, which is basically a mobile infrared grating spectrometer. The infrared light source and receiver units were equipped with telescopic optics to permit long-path (up to 3 km) measurements. The measured gas concentrations obtained in this manner are the same concentrations that would be obtained if the gas molecules were uniformly distributed over the optical path length.

The sites (optical paths) for the ROSE measurements were chosen to correspond with major WAFB operations. They were located to be near conventional point sampling stations (not in operation at the time of the ROSE measurements). In Figure B-6, the five sampling sites are indicated by "SS," and the paths used for the ROSE measurements are indicated by a line connecting a pair of letters (e.g., "A" indicates the ROSE van location and "A*" indicates the light-source location). Characteristics of the paths are sumarized in Table B-5.

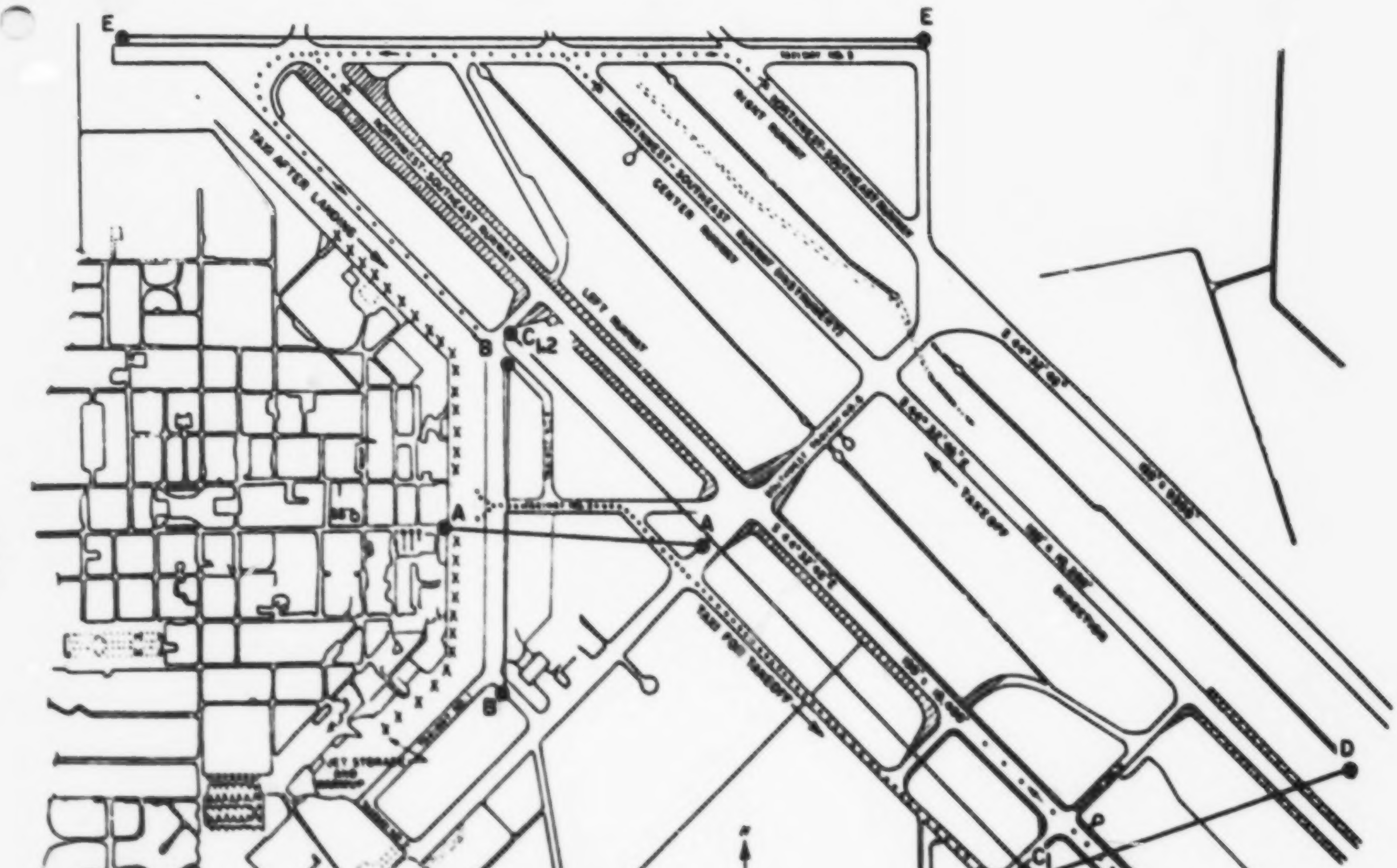
E
E
A
A
B
B
C1,2
C1
C2
D
D
TAXI AFTER LANDING
NORTHWEST-SOUTHEAST RUNWAY
LEFT RUNWAY
NORTHWEST-SOUTHEAST RUNWAY
CENTER RUNWAY
NORTHWEST-SOUTHEAST RUNWAY
RIGHT RUNWAY
TAKEOFF
DIRECTION
TAXI FOR TAKEOFF
JET STORAGE
N

Figure B-6. ROSE measurement sites at WAFB.

TABLE B-5. LONG-PATH MEASUREMENT LOCATION SUMMARY

Date	Path	Time	Range (m)	Comment
2-10	A	1200-1800	670	
2-11	A	0630-1500	670	Vicinity of jet warmup, taxi,
2-11	B	1700-1800	810	and shutdown ("X's" in Figure 1)
2-12	B	0615-1730	810	
2-13	C_1	0830-1630	1880	Parallel to main taxiway
2-17	C_2	0630-1530	1940	
2-18	D	0900-1650	1150	Across taxiway and runways
2-19	E	0630-1645	2140	Across north boundary of WAFB

The CO spectrum covers the spectral region from about 2,040 to 2,240 cm^{-1}. Water vapor interferes towards the low wave number side and renders the region below about 2,150 cm^{-1} useless for CO analysis in the long-path measurements. Most of the spectra were recorded from 2,150 to 2,250 cm^{-1} with spectral resolution of about 1 cm^{-1}.

A total of 236 individual CO concentration measurements were made during the seven days of long-path data collection. Highest average CO concentrations of about 4 ppm were measured along path A. For this path, those concentrations above about 1.2 ppm were obtained when the optical path was traversed by an individual jet plume for an appreciable period of time. Along other optical paths most concentrations remained under 1 ppm. An exception was at 1407 hours on path E; at this time there were five jets idling at the east end of taxiway 5 (about 20 m south of the optical path), and the path-averaged concentration was measured at 3 ppm.

Visual observation of the jet exhausts and the fact that the highest CO concentrations occurred along path A (as opposed to path C) suggested that the jet plumes were rising very quickly.

CORRELATION SPECTROMETER STUDY

Environmental Measurements, Inc. (EMI) performed six days of measurements from October 20 to 27, 1976, using the Barringer COSPEC. The goal was to document NO_2 pollution flux entering and leaving the base. Additional data were gathered on regional pollution levels in the greater Phoenix and in the vicinity of Sky Harbor Airport. Total sulfur measurements were used as indicators of external emissions entering the WAFB area.

An EMI moving laboratory measured SO_2 and NO_2 overhead burdens with the COSPEC remote sensor and total sulfur (TS) and NO_x at ground level with continuous analyzers. The remote sensing COSPEC was also mounted on a tripod near the taxiway, site 3, WAFB, and vertical and horizontal profiles of NO_2 were made over two different intervals. The main goal was achieved by circumnavigating the base on the perimeter road that circled the main aircraft operations area. The basic perimeter traverse was 13.5 km long and required 25 minutes to complete. These measurements around the base were carried out 25 times in six days. Typical readings and peak values for both total burden and ground-level measurements are tabulated below:

	Typical	Peak
SO_2 total burden (ppmM)*	20-60	157
NO_2 total burden (ppmM)	20-40	152
TS ground-level (ppb)	0-5	12
NO_x ground-level (ppb)	50-150	905

* ppmM = parts per million - meters

As tabulated above, the typical SO_2 values varied over 40 ppmM while the NO_2 varied over a 20 ppmM band. This difference documented expectation, though further analysis of the data would be required to provide a qualified observation. The moving laboratory measurements indicated:

- Ground-level TS at low concentration showing external emission of this type entering WAFB to be limited
- Ground-level NO_x variation with automobile traffic in the area and perimeter of WAFB

Results of the greatest potential value were the ground-level NO_x data showing varying levels at WAFB and at Sky Harbor Airport (near Phoenix), which can be used to document transport of Phoenix metropolitan emissions into the WAFB area. The stationary COSPEC results suggest a higher relative concentration "bubble" of NO_2 to the northwest of WAFB toward the Phoenix area. A peak concentration has not been computed. This bubble peak was ~30 ppmM at 2° elevation north-northwest of WAFB. A detailed report on the study is available in the EMI report, "Moving Laboratory Survey at Williams Air Force Base," [24].

GAS-FILTERED CORRELATION SPECTROMETER STUDY

Three nondispersive infrared instruments were used at WAFB for long- and short-path remote sensing measurements [11]. A gas-filtered correlation (GFC) spectrometer depends for its sensitivity on the correlation between the structure in the spectrum of the gas species to be measured and that of the same species in the correlation cell. Generally, the spectral bandpass of the instrument includes several absorption lines so that there will be large fluctuations in transmittance at different wavelengths when the beam traverses the correlation cell. The most important advantage of the GFC technique over other nondispersive infrared techniques is its ability to discriminate against particulate matter and gas species other than the one being measured.

Peak height and duration of the CO signal from the nondispersion infrared instruments caused by jet plumes depended primarily on ambient WS and WD. The study did not directly yield sufficient information on the plume rise. The velocity of the rise during the short length of time the plume was observed was too small for observations perpendicular to the runway with a single GFC instrument. Response time of the instrument is too slow, and in situ wind velocity determinations are also limiting factors in this development since the higher CO concentration parcel is not present for a sufficient period of time.

SCANNING LASER DOPPLER VELOCIMETER SYSTEM INVESTIGATION

Data from a scanning laser Doppler velocimeter system (SLDVS) were prepared to determine the feasibility of using the system to map the concentration of particulate pollution in the atmosphere around airports in the context of the overall USAF program. The system was operated at Kennedy International Airport from September 1974 through May 1975 for the purpose of detecting and tracking aircraft wake vortices during landings on runway 31R. Since the system measures laser radiation backscattered by particles in the atmosphere, it was postulated that the data from the system could be used to determine the concentration of these particles. The data consisted of tape recordings of digitized spectra along with time and spatial coordinates. In this investigation, the total signal was plotted as a function of vertical and horizontal position during the time required for the system to make a single scan through a vertical plane perpendicular to the end of runway 31R. Approximately 450 such vertical signal profiles were prepared from data taken during 50 landings on five separate days in the spring of 1975.

A preliminary analysis of the data was performed to determine the relationship between signal and atmospheric backscatter coefficients and to evaluate the general quality of the resulting data. This data analysis indicated that the system was successful in measuring changes in returned signal strength, based on the repeatability of data from scan to scan.

In summary, the principle of using an SLDVS for airport pollution monitoring of atmospheric backscatter coefficient appears to be feasible. A reasonable amount of data was obtained and processed with the system at Kennedy International Airport. To obtain data of value to the WAFB project, however, further extensive development of an optimum system configuration specific to dispersion particle size at WAFB would have to occur. A complete report of this study, including vertical scans has been prepared by Raytheon Company [25].

APPENDIX C

MEASUREMENT PRINCIPLES AND PERFORMANCE SPECIFICATIONS FOR WAFB ANALYZERS

This appendix provides the principle of measurement and the performance secifications for CO, NMHC, and NO_x specified for the two multicomponent analyzers used at Williams AFB. It also presents a brief narrative of the sampling procedure to obtain scattering coefficient measurements with the integrating nephelometer and to record wind speed and direction measurements.

Section 4 of this report presented the standard deviation of calibration of the air quality analyzers used at Williams AFB. Sections 2 and 3 described the preliminary study used in part to select the sampling and analytical procedures for CO, HC corrected for methane (as methane), and oxides of nitrogen (NO_x); the study was also used to designate performance specifications. However, to assess the actual instrument performance, the current practice and experience of other investigators are presented. These are provided to allow the reader to compare the demonstrated performance at Williams to that normally expected as a result of experience developed since mid-1976, when the two methods were published in the Federal Register.

The following discussions first present the general characteristics of the analytical methods selected for use at WAFB. Where possible, the precision and accuracy obtained by other investigators are provided. The application of sampling and analytical procedures for monitoring operations in the field usually results in two levels of performance: 1) the anticipated performance specified during procurement and monitoring operations; and 2) the actual performance achieved using current technology to calibrate the method under actual field conditions.

The technology of air quality measurement systems has evolved since 1973. The measurement systems employed at WAFB were tested in 1975 and purchased early in 1976. The measurement of emissions at WAFB included emphasis on nonmethane hydrocarbons (NMHC) or, more precisely, total hydrocarbons corrected for methane and measured as methane. No assumptions are made regarding the instrumental response to hydrocarbons or substances other than methane. Carbon monoxide was also measured using the same instrumental configuration. After conversion to methane, it was measured as methane. The calibration required to permit the determination of NO_2 concentrations from an analyzer that measured NO and NO_x was not specified until December 1976, after monitoring operations of air quality had begun in June 1976.

Current accepted procedures for measuring the performance of automated air quality measurement methods are well documented, and they provide a mechanism for arriving at the relative precision and accuracy of the analyzers. Instrumental precision (over the full range of measurement) is normally determined by performing calibrations at multiple concentration levels throughout the range. Independent audits of performance are also used to develop accuracy statements, as in the case of State and local monitoring programs. Calibration at several different concentration levels and independent audits of the calibration process were not performed at WAFB. Calibration records were utilized in order to assign precision uncertainty to the data for the WAFB analyzers. Calibration traceability to acceptable standards was also utilized to provide further information about the measurement accuracy of the data collected at WAFB.

Performance specifications for the air quality and meteorology analyzers used at WAFB were determined by EMSL-LV and are representative of comercial instrumentation available in 1975. These specifications are presented so that study analysts can evaluate the data collection process in terms of expected instrumental precision and accuracy. An analysis of the measurement precision and accuracy limits obtained in the field is presented in Subsection 4.3.

SAMPLING AND ANALYTICAL PROCEDURE FOR CO, CH_4, AND TOTAL HYDROCARBON - BECKMAN MODEL 6800 GAS CHROMATOGRAPH

Principle

Measured volumes of ambient air are delivered 4 to 12 times per hour to a gas chromatographic column where HC, CO_2, and H_2O are separated from CH_4 and CO. Methane is transferred and measured in a hydrogen flame ionization detector. Carbon monoxide is eluted to a catalytic reduction tube and reduced to CH_4 before passing through the flame ionization detector. Hydrocarbons are transferred quantitatively to the detector, and NMHC is determined by subtracting the CH_4 from the total hydrocarbon (THC) value [31].

Application

The method is applicable in its most sensitive range to semicontinuous measurement of THC, CH_4, and CO in ambient atmospheres over the range 0.050-0.2 ppm for THC, 0.050-1 ppm for CO, and 0.050-2.0 ppm for CH_4 [32] (ASTM Book of Standards, 1978, Part 26, D3416-78). The range can be extended to higher concentrations.

Calibration

Calibration gases of 5 percent, 15 percent, 40 percent, and 80 percent of full-scale concentration range are used to determine linearity of the flame ionization detector response to each component. The calibration gases consist of two component mixtures of CH_4 and CO and are used for all three components analyzed, since each constituent is determined as CH_4.

Precision

Precision of repeated measurements of calibration gases is ± 0.5 percent of full-scale at higher concentrations (10 ppm). At lower concentrations, precision of repeated measurements is 2 percent of full-scale. However, NMHC measurements can vary 0.322 ppm on the average, and standard deviation between different instruments can range from 0.217 to 0.454 ppm [33].

Accuracy

Accuracy is conditional on the purity of zero air and calibration standards. Performance audits using standard materials supplied by EPA have demonstrated that CO measurements by the flame ionization detector over a range of 3.43 ppm to a nominal 40.6 ppm produced an average difference of 2.3 percent [34].

Performance Specifications

- Automatic analysis 12 times per hour
- Range selection from 1 to 10 ppm full scale
- Precision of the greater of ± 0.5 percent of full scale or 0.05 ppm
- Linearity of ± 1 percent of full scale
- Compensated zero drift that is automatically adjusted during each 5-minute analysis cycle
- Output of 0 to 5 Vdc

The Beckman instruments, after installation in the remote stations, were factory serviced and checked for proper operation by Beckman service engineers. An orientation course was held for USAF and contractor monitoring operation personnel.

SAMPLING AND ANALYTICAL PROCEDURE FOR MEASURING NO AND NO_x BY CHEMILUMINESCENCE - MONITOR LABS MODEL 8440 ANALYZER

Principle

The chemiluminescence procedure for measuring NO_2 employs gas phase reactions of NO and O_3 to form NO_2 and light. Detection of NO_x ($NO + NO_2$) requires conversion of NO_2 to NO since it is directly proportional to NO in the presence of excess O_3. In most cases, NO_2-to NO converters are capable of quantitative conversion for long periods before needing maintenance [35].

Application

This principle is an EPA Federal Reference Method and has application in ambient and automated monitoring networks ranging from 0.005 to 1 ppm giving a linear response over these concentrations.

Sampling

The chemiluminescence instruments sample continuously and have a rapid response (less than 2 seconds). NO_x and NO measurements produce NO_2 measurements by difference in data processing.

Calibration

Gas phase titration is recommended for concentrations ranging from 0 to 1 ppm. Calibration should be done on a monthly basis coinciding with converter (NO_2 to NO) efficiency checks. Instrumentation may be calibrated with NO_2 either from gas phase titration of NO with O_3 or from an NO_2 permeation device.

Precision

Zero and span checks are required weekly, at a minimum, to determine precision within current guidelines [36]. The weekly span check should provide NO_2 concentrations between 0.08 and 0.1 ppm with a control limit of ± 0.025 ppm.

Accuracy

Accuracy is affected by small interferences from NH_3 and other compounds that convert to NO or decompose to NO in the sample converter. The NH_3 interference is eliminated by operating the converter at a temperature of less than 400°C. Accuracy data are acquired with quarterly performance audits using different standards and equipment to provide test atmospheres. Permeation tube and gas phase titration calibration should show agreement within ± 5 percent [37, 38].

Performance Specifications

- Detection limit of 2 ppb for NO, NO_x, and NO_2
- Span stability of less than ± 1 percent per day from all sources, with instrument ± 5°C from calibration temperature and less than ± 2 percent span drift per 14 days with instrument ± 5°C from calibration temperature
- A maximum temperature span coefficient of 0.2 percent per degree Celsius over the range 25°C ± 20°C
- Zero instability of less than 0.1 percent full scale per month, ± 3°C from set temperature 0.025 percent per degree Celsius

- Lag time less than 3 seconds from a step change at the input
- Repeatability of ± 1 percent for NO and NO_x output
- Operating temperature of 0°C to 50°C
- Measuring ranges of 0.05 ppm, 0.1 ppm, 0.5 ppm, 1 ppm, and 5 ppm full scale (0.5 ppm range used at WAFB)
- Response time of 1.0 second, 5 seconds, 20 seconds, and 1 minute nominal, switch selectable. (These are the time lags for the instrument to reach 63.5 percent of a constant input concentration.)

SAMPLING AND ANALYSIS PROCEDURE FOR MEASUREMENT OF SCATTERING COEFFICIENT WITH THE INTEGRATING NEPHELOMETER - METEOROLOGY RESEARCH, INC., MODEL 1550B

Principle

An air sample drawn continuously through the instrument at a rate of about $1.4 \times 10\ m^3/min$ is periodically illuminated by a xenon flashlamp, and the amount of light scattered by the aerosol is measured by a photomultiplier detector. The geometric configuration of the integrating nephelometer is such that the instrument integrates the scattering over a range of angles from 9° to 170°, measuring the approximate extinction coefficient as a result of scattering, b_{scat}.

Application

The integrating nephelometer will measure the scattering coefficient, b_{scat}, for most normal ambient atmospheric aerosols. Exceptions are those aerosols composed primarily of large particles -- for example, very wet fogs and large particles and dark-colored particles. Research has shown that there is a good correlation between the scattering coefficient and the mass concentration of particulates in the ambient atmosphere, when the instrument is calibrated for this application [39]. The MRI integrating nephelometer can be used to measure scattering coefficients over the range of $0.1 \times 10^{-4} m^{-1}$ to $100 \times 10^{-4} m^{-1}$. The scattering coefficient for particle-free air is $0.23 \times 10^{-4} m^{-1}$ at sea level (at the effective wavelength of the instrument), and it decreases with altitude. Efficiency of sampling systems is typically 90 percent and the range of the instrument is approximately the scattering produced by ambient aerosol concentration of 0 to 3800 $\mu g/m^3$.

Interferences in mass measurement are those of gases and, if dry aerosol mass is of interest, of moisture on the particles and size distribution. If the scattering solely from the atmospheric aerosol is desired, then the contribution from gases must be removed. Scattering coefficient of clean air at sea level is $0.23 \times 10^{-4} m^{-1}$, which may be subtracted from the overall scattering coefficient to arrive at the aerosol contribution. The effect of other gases in the ambient atmosphere is negligible. The maximum zero drift to be expected over a period of several days corresponds to a change in scattering coefficient of about $0.1 \times 10^{-4} m^{-1}$, i.e., less than 1 to 2 percent of a typical urban aerosol reading and less than 10 to 20 percent of the readings encountered in clean desert air. The gain drift over the same period of time is less than 3 percent of a reading.

Calibration

Calibration of the integrating nephelometer is normally accomplished using filtered cylinder air for zero input and a known flow of Freon 12 for span input. The instrument response is then set to correspond to these inputs, both of whose scattering coefficients are known and predetermined. In addition, the linearity of the instrument response may be checked using internal electronic circuitry.

Precision

The root mean square precision of the integrating nephelometer in actual use is between 3 and 4 percent of the reading of scattering coefficient for the normal ambient atmospheric conditions. A slight decrease in precision may occur for readings in extremely clear air, with the exact degree depending on the care exercised in calibration of the instrument. The precision in visibility and mass concentration is the same as that for the scattering coefficient [40].

Accuracy

The accuracy of the integrating nephelometer is better than ± 10 percent of reading of scattering coefficient for the normal ambient atmospheric aerosol, based on theoretical computation of the scattering and actual experience with the linearity of the instrument. The accuracy is expected to be somewhat poorer for aerosols composed primarily of large particles or droplets (e.g., dust storms, fogs) with a maximum expected error of 35 percent.

Performance Specifications

- Scattering coefficient (b_{scat}) of 0 to 10 x $10^{-4}m^{-1}$ or a local visual distance of infinity to 1.6 km or a mass concentration (approximately) of 0 to 380.0 $\mu g/m^3$
- System accuracy of ± 10 percent of full scale for b_{scat} and local visual distance
- Output of 0 to 5 volts (V) full scale, which was later changed to 0 to 4 V full scale

WIND SPEED AND DIRECTION SENSORS - R.M. YOUNG GILL PROPELLER VANES

Principle

An integrated sensor unit is mounted on a vertical support above any surrounding obstructions (vegetation, buildings, terrain). A rotating propeller responds to wind movement, and a directional vane rotates to respond to the prevailing wind direction. Wind speed is recorded by measuring the revolutions per minute (rpm) of the propeller assembly and wind direction is measured as an angular deflection of the vane assembly away from a preset reference point (corresponding to true north at the site location).

Calibration

The wind-speed cup assembly is calibrated by connecting a known-rpm electric motor assembly to the propeller shaft and adjusting the rpm output to correspond to the standard motor. The wind direction vane assembly is calibrated by setting the true north (zero deflection) reference line either visually with a theodolite or by comparison to a magnetic compass reading (as corrected for geographical declination).

Precision

The R.M. Young assembly is capable of measuring wind speeds to within ± 0.05 m/s above the threshold of 0.25 m/s.

Performance Specifications

- Threshold of 0.25 m/s
- Range of 0 to 40 m/s
- Output of 0 to 4 Vdc for WS
- Distance constant of one revolution for propeller vane per 30 cm of air flow (The distance that air flows past the propeller while the propeller responds to 63.2 percent of a step increase or decrease in wind speed.)
- Range in WD of 0 to 352 degrees (8 degree deadband from 352 degrees to 360 degrees) in the deadband, voltages greater than full scale are rejected by the computer editing programs.
- Potentiometer linearity of 0.25 percent for WS output reading
- Output of 0 to 3.52 Vdc for WD

ACCESSORY EQUIPMENT FOR EACH STATION

- Elhygen Mark IV hydrogen generator used to supply hydrogen (H_2) gas to the Beckman Model 6800 gas chromatograph. (Considerable problems were encountered in the use of this instrument; subsequently bottled H_2 was used.)
- Sola Electric constant voltage transformer of the harmonic neutralized type to protect the equipment against power fluctuations and transients

- Heat/cool airconditioner capable of maintaining the internal temperature of the monitoring stations to ± 2°C of a present value

- Standard air-sampling glass manifolds of nominal 2.5-cm diameter with moisture and particulate traps, including glass ballast volume for Beckman 6800 gas chromatograph to provide a sample air residence time (ratio of volume to flow rate) of approximately seven times the interrogation rate of the data acquisition system

STATION ENCLOSURE SPECIFICATIONS

Air quality trailer station enclosures (Westinghouse model 66204-70 or equivalent), were used as shown in Figure C-1.

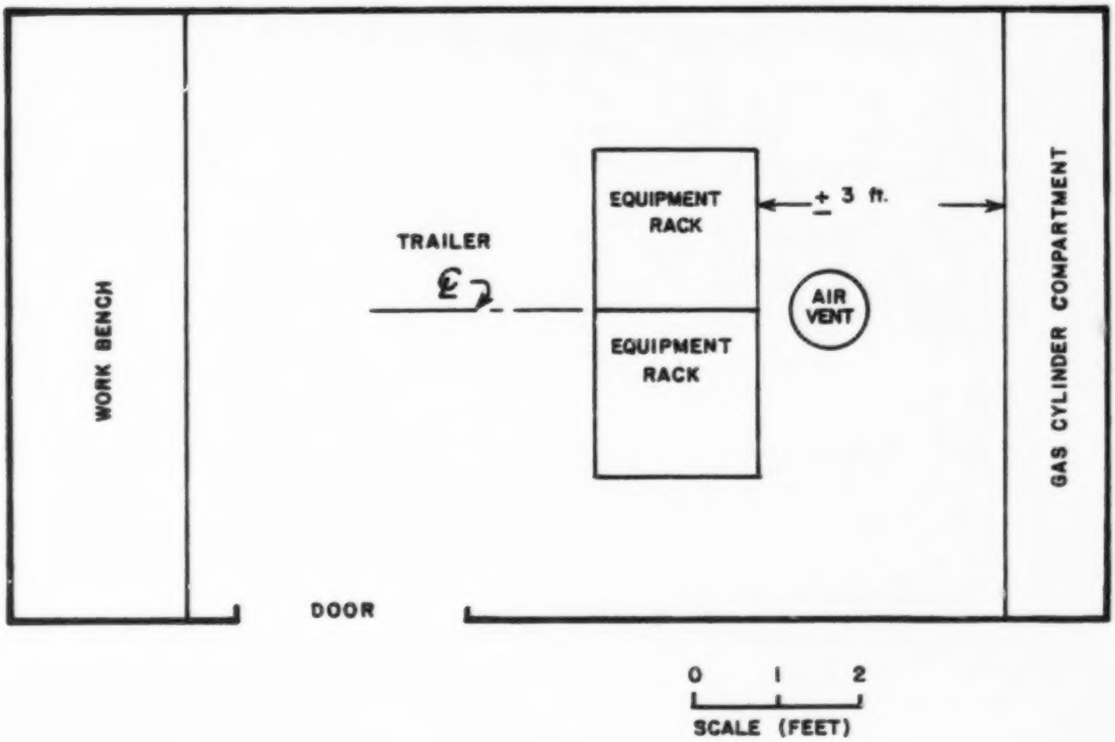
WORK BENCH
TRAILER
℄
EQUIPMENT RACK
EQUIPMENT RACK
± 3 ft.
AIR VENT
GAS CYLINDER COMPARTMENT
DOOR
0
1
2
SCALE (FEET)

Figure C-1. Interior floor plan of air quality monitoring trailer.

- Length 4-4.5 m, 5-5.9 m with tongue

- Width 2.4 m, height 2.4 m from ground to roof

- Steel underframe
- Wood or metal body
- Sheet aluminum exterior; prepainted outside aluminum at least 0.48 mm thick, minimum 6 mm plywood backing or equivalent
- Running gear: 2 axles, for 1362 kg payload
- Hitch weight: not greater than 363 kg or less than 181 kg
- Forward frame extension crank handle adjustment for leveling independent braking system; electric brakes on one axle; and breakaway safety system
- Body watertight, entry door sealed against weather
- Insulation: fiberglass and vapor barrier, floor and wall 7.6 cm, ceiling 15 cm
- Subfloor: exterior grade plywood 1.9 cm thick with protective covering of erosion-resistant sheet steel on underside
- Interior floor: vinyl asbestos tile or sheet 2.3 mm thick, residential grade
- Interior wall: finished plywood paneling
- Ceiling: 1.27 cm acoustical tile, white, textured, residential grade
- Leveling pad and jack at each corner of frame
- Entry door with panic bar, width 91 cm, height 2 m
- Roof cover: nonreflective, nonskid coating
- Roof structure: capable of supporting 726 kg, toe plate, ladder: 2.5 cm steel, 35.6 cm wide, 40.6 cm between rung, offset 19 cm from the back of trailer; roof railing: height 1 m
- Inside heating and cooling thermostat - residential type
- Two wall cabinets, height 76 cm, width 68 cm, depth 32 cm
- Counter top, length 1.85 m, depth 61 cm, composition: Formica on 1.8 cm plywood
- Two base cabinets mounted on floor, height, 86.4 cm, width 83.8 cm, depth 61.1 cm
- Gas bottle compartments capable of holding four gas T-size cylinders, double doors or single swing-up door to outside to replace cylinders

- Power: 150 amperes (A), 115/230 V, single phase, 60 hertz (Hz)
- Heating and lighting: all electric equipment to operate at 115/230 Vac
- Circuit-breaker panel design for underground hookup and provisions for 11 circuits
- Main switch provided to disconnect power to everything
- Three conductor wires throughout
- Six interior duplex outlets
- Three exterior all-weather 120-V duplex outlets -- 2 on roof and 1 on road side wall
- Interior lights: 1.22-m double flush-mounted fluorescent lights
- Air-conditioner/heater: 23,000 Britich thermal unit (Btu) cooling, 13.5 kilowatt (kW) heating

APPENDIX D

CALIBRATION PROCEDURES FOR AIR QUALITY MONITORING INSTRUMENTATION

The instrument performance results presented in Section 4 were derived from calibration and daily calibration check data recorded continuously during the field monitoring period. This appendix presents the procedures utilized at WAFB for station calibration. These procedures are a vital link between the measured data set and the analyses presented in Section 5 with respect to impact assessment and rational air quality standards.

BECKMAN 6800 AIR QUALITY GAS CHROMATOGRAPH

The Beckman gas chromatograph utilizes the principle of flame ionization detection for continuous measurement of volatile organic materials in the atmosphere. The principle of operation is the differentiated production of a relative number of ions in both a pure hydrogen flame and a flame containing hydrocarbon molecules. The sensing device unit contains a gas-mixing chamber and burner, an igniter and polarizing electrode, and an ion collector and vent. Positively charged carbon atoms (ions) produced in the flame are drawn to the negatively charged collector where the charge is neutralized by electrons produced in a high-impedance amplifier.

Through calibration using known hydrocarbon type, physical alignment of the detector, the maintenance of carefully controlled combustion conditions, the number of electrons produced in the process will generate a voltage proportional to the number of carbon atoms present. Relative response for various organic compounds has been correlated by numerous investigators [17]:

Organic Class	Effective Carbon Number
Aliphatic carbon atom	1.0
Aromatic carbon atom	1.1
Olefinic carbon atom	1.2
Acetylenic carbon atom	1.4
Carbonyl carbon atom	0.0

This principle of measurement was selected because of the ease of operation over wide concentration ranges, the automatic zeroing feature, the relative insensitivity of the system to air and water vapor, and the ability for subtraction to compute NMHC concentrations for use in data processing. There are several possible disadvantages to this type of pollutant sensor: the background electronic noise must be below the minium carbon atom signal level at the lower end of amplitude range of approximately 10^5 to 1; the analyzer requires a skilled operator; the analyzer lacks total specificity in the absence of a means to separate individual constituents; and calibration to obtain uncertainty limits for hydrocarbon compounds (THC) is very difficult.

The air quality chromatograph provides voltage signals for CO, CH_4, and THC using two separate output signals. One is a 0-10 millivolt (mV) recorder output from the flame ionization detector used for programming and troubleshooting the instrument. The second output signal is from each component monitored and goes to three separate 0-5 V memory outputs, which store and hold peak voltage until it is updated after each component analysis is completed. The three memory outputs (CO, CH_4, and THC) were used for data acquisition in normal operation at WAFB.

The calibration procedure was the same for the recorder and memory output voltage, each being adjusted with a separate attenuator located on the individual component cards, as recommended in the Beckman Instruction Manual, 614-082181-B.

Calibration was begun when the chromatograph had been started according to the recommended startup procedure. Calibration ranges of operation were selected according to the following:

- THC (as methane) was calibrated on range 2 between 2 and 20 ppm. Range 3 increased full-scale range by a factor of 10.
- CH_4 and CO were calibrated on full-scale range, variable between 1.2 and 12 ppm. Ranges 2 and 3 multiplied range factors by 10.

To start the calibration, the following switches (see Instruction Manual) were checked for function:

- Manual/Auto, in Auto position
- Calibrate/Operate, in Operate position
- Manual Att/Auto Att, in Auto Att position
- Single/Continuous, in Continuous position
- Start, off
- Reset, off
- Flame Out Override, off
- Auto Zero, off
- Calibration Standard, off

- Chart Advance, off
- Valve C, off
- Valve B, off
- Valve A, off

Flow rate at the sample vent was measured with a flowmeter capable of measuring flows in the range of 150 cm^3/min. This value was recorded for future reference. At any point that tests were not acceptable, the procedure was discontinued and corrective action was implemented. Calibration then proceeded through the following steps.

The electronic zero for each component was checked with the Single/Continuous switch in the Single position and watched for the reset light to come on, indicating the end of a complete cycle. The Manual/Auto switch was then placed in Manual position. The Start switch was activated momentarily, and Auto Zero switch was then turned on. The next sequence of the test involved component cards for CO, CH_4, and THC located in the lower drawer of the gas chromatograph. A digital voltmeter was connected to the memory test point of the component card to be checked, and the Manual/Auto switch was placed in Manual position. The output signal was adjusted to zero with the zero attenuator, if indicated. The Manual/Auto switch for that card was then placed in Auto position. This procedure was repeated for the remaining two component cards. After all three cards were tested or adjusted, the Auto Zero switch was placed in the Off position, and the gas chromatograph returned to the reset condition.

Ultrapure air was next introduced into the calibration inlet, and the following switches were set:

- Manual/Auto to the Auto position
- Single/Continuous to the Continuous position
- Standard Calibration to On

Flow was measured at the sample vent, compared to the value recorded prior to step 1 above, and adjusted with the regulator on an ultrapure air bottle.

The gas chromatograph was operated in automatic mode for two or more complete cycles, followed by tests on the memory outputs of all three component cards. Ultrapure air was then removed from the calibration inlet. The ultrapure air response was required to be within 1 percent of the electronic zero or calibration was discontinued.

The calibration gas was connected and flow at the sample vent was measured and adjusted as in step 2 above. The gas chromatograph was operated on calibration gas for two or more complete cycles (10 minutes). Memory outputs were monitored for the next three cycles. If tests were repeatable to within 1 percent of full scale, the instrument was then calibrated with span gas.

By placing the Single/Continuous switch in the Single position and waiting for the reset light to come on, indicating the end of a cycle, automatic cycling was stopped. Signal outputs for the three components were measured and recorded for the cycle just completed. The gas chromatograph was then placed in the span calibration mode by setting the front panel switches as follows:

- Manual/Auto, to Manual position
- Calibrate/Operate, to Calibrate position
- Manual Att/Auto Att, to Auto Att position
- Manual Range, to 10 position

Signal outputs were turned on by momentarily actuating the Start switch. For the component to be calibrated, the Manual/Auto switch at the top of that component card was placed in the Manual position. The calibration control on the front panel was then adjusted to compare with the signal voltage for that component.

Using known concentrations of the calibration gas, measured signal output, and full-scale signal output, the new full-scale range was calculated with the following formula:

$$\text{new full-scale range (ppm)} = [\text{cal gas (ppm)}]\ \frac{\text{full-scale signal (V)}}{\text{signal measured for cal gas (V)}}$$

Voltage of the signal output required to produce the full-scale range was calculated by:

$$\text{signal out (V)} = \left[\frac{\text{cal gas (ppm)}}{\text{desired full scale (ppm)}}\right] \text{(full scale voltage signal)}$$

Signal output voltage was then obtained by adjusting the respective recorder or memory attenuator, located on the component card. The component card Manual/Auto switch was then switched to the Auto position.

This procedure was repeated for the remaining two components and the gas chromatograph was placed in automatic mode, setting the front panel switches in the following positions:

- Calibrate/Operate switch to Operate
- Manual/Auto switch to Auto

ML MODEL 8440 NO-NO_x ANALYZER

Procedures utilizing dilution atmospheres and cylinders of known concentration were used for the span calibration of NO/NO_x. Dilution of a gas cylinder containing 50 to 100 ppm nitric oxide with a dynamic dilution system to the calibration level of about 0.4 ppm required precise regulation of gas flow and a source of ultrapure air for the dilution gas. Flow control was maintained by a Bendix Model 8852 Dynamic Calibration System. Ultrapure air was supplied by an AADCO pure air generator with a Gast Teflon-ringed compressor. Calibration gas was also introduced directly into the instrument from low concentration cylinders of NO in nitrogen and NO_2 in air.

The ML 8440 measured NO and NO_x, and each output had to be calibrated separately for zero and span. The difference may be calibrated to read as NO_2; however, NO_2 is not measured directly by the instrument.

Several hours of operation were allowed to stabilize the electronics and reduce the reaction chamber's background illumination to manufacturers' specifications. The background illumination must be less than an equivalent output of 20 ppb of NO, determined by taking the difference of the instrument output with the ozone generator turned on and off, while the instrument is sampling ultrapure air. After this test was completed, the ozone generator was returned to the On position.

The operator then selected the appropriate full-scale calibration range with the five-position, front-panel range switches for NO and NO_x. Although the outputs were independent, the same range had to be used for each. A range was normally selected so that the span gas concentration would be close to 75 percent of full scale for routine calibrations. The standard range selected was 0.5 ppm.

The operator then selected the desired level of signal averaging with the resistance-capacitance time-constant front-panel switches. Time constants were selectable for 1, 5, 20, and 60 seconds. These were the times required for the signal output voltage to reach 63.5 percent of full-scale concentration. Normally the 60-second time constant was selected since it provided the most stable response for calibration.

After range and time-constant selection had been completed, ultrapure air was introduced into the sample inlet connection. A T in the sample inlet line was provided, with one branch connected to a flowmeter and the input flow adjusted until there was an excess flow of ultrapure air. The inlet gas flow could not be so great that a significant positive pressure developed in the analyzer.

The instrument was allowed to stabilize for 5 to 10 minutes while sampling ultrapure air. The zero attenuators for NO and NO_x were adjusted until the output signal read zero volts. Five minutes were allowed after each adjustment for the instrument to stabilize at the new settings. The final zero voltages and attenuator settings were recorded.

The sample inlet was then removed from ultrapure air and connected to a calibration gas with a certified value. The excess flow was reestablished with the flowmeter and adjusted to approximately the same level as was used for ultrapure air. A period of 5 to 10 minutes was required for the instrument to stabilize on the span gas concentration. The span attenuators for NO and NO_x were adjusted to produce the proper calibration voltage. This voltage was determined using the following formula:

adjusted calibration voltage =

$$\frac{\text{span gas concentration (ppm)}}{\text{full-scale range (ppm)}} \times \text{full-scale volts}$$

After each attenuator adjustment, 5 minutes were allowed for the instrument to stabilize at the new value. After the final adjustments had been made, the adjusted calibration voltages and the span attenuator settings were recorded.

The sample inlet was disconnected from span gas and the ambient air was then connected to the manifold. Five minutes were allowed for the instrument to start reading ambient air concentrations.

MRI MODEL 1550B INTEGRATING NEPHELOMETER CALIBRATION

Calibration of the MRI Model 1550B integrating nephelometer consisted of introducing two gases (pure air and Freon 12) with known scattering coefficients, b_{scat}, into the optical measuring assembly. The instrument response for each gas was adjusted to read the value of b_{scat} for that gas. With two points of the nephelometer scale set, the instrument was fully calibrated, assuming that the output is linear in units of scattering coefficient.

To verify the full-scale response of the instrument at a later date without having to inject the Freon 12 calibration gas, a check of the electronic response to a constant light source directed toward the nephelometer phototube receptor was made at the time of the full calibration. The specific instrument response to this test was noted and was used as a check point for instrument span during subsequent checks of calibration.

Before calibration, the instrument was properly set up as stated in the instruction manual. The instrument was placed on line for at least one hour for stabilization before calibration, during which time it was operated in the following mode to establish the pure air set point:

- Data system switch for channel 8 in position 9 (inoperative)
- Range switch on front panel of electronic unit in position A/C
- Function switch in the pure air position
- Air intake and exhaust hoses on the optical assembly disconnected and the intake tube plugged with Kimwipes, soft cloth, or other flexible and porous material, and outlet pipe plugged with a rubber stopper
- Clean, filtered air from blower unit flowing into assembly

If the instrument was previously operating in the sampling mode continuously for more than one hour, only 20 minutes were required for the clean air to purge the optical assembly so that the pure air set point could be established.

After the stabilization period, the background potentiometer was adjusted until the scattering coefficient read $0.23 \times 10^{-4}m^{-1}$, thereby setting the first point on the nephelometer readout scale.

The clean air line was then removed from the blower unit and connected to a can of Freon 12 equipped with a valve, a slow restrictor, and a filter assembly. The valve was opened and Freon 12 introduced into the optical assembly until the output was stable for 5 minutes. If the nephelometer readout value was the desired theoretical value of $3.6 \times 10^{-4}m^{-1}$, the data switch for Channel 8 was moved to Position 3 and left for 5 minutes while the data system polled 5 times. If the readout was not $3.6 \times 10^{-4}m^{-1}$, but was within $0.2 \times 10^{-4}m^{-1}$ of that value, an adjustment was performed using the gain potentiometer on the front panel prior to switching for data system polling. If an adjustment of more than $0.2 \times 10^{-4}m^{-1}$ was required, the adjustment was made with the gain potentiometer as before; however, the output was not polled by the data system since this misalignment indicated a possible improper setting of the pure air data point. In this case, the pure air data point was rechecked prior to establishing the Freon 12 data point.

After the Freon 12 point was set and recorded by the data system, Channel 8 was switched to Position 9. Pure air was then again used to purge the optical chamber, and the instrument reading, $0.23 \times 10^{-4}m^{-1}$ was polled five times by the data system by setting the Channel 8 switch to Position 2 (adjusted pure air) for 5 minutes. Channel 8 was then switched to Position 9 (inoperative). The two calibration points were thereby established.

The final requirement of calibration was to establish a value of cal check response. To do this the optical assembly was prepared for pure air as was described previously, and a 20-minute purge time was allowed. The function switch was then rotated to the cal check position. Five additional minutes were allowed for the cal check value to be reached. Channel 8 was then switched to Position 4 (adjusted cal check) and 5 minutes were allowed for data system polling. The Channel 8 switch was then returned to Position 9 (inoperative) and the instrument calibration was complete.

The instrument was then prepared for routine monitoring by first removing the material from the intake tube and the rubber plug from the exhaust tube. The intake and exhaust hoses were then reconnected. The function switch was moved to the run position and the desired scale was selected with the scale-selector switch. A period of five minutes was allowed for the instrument to stabilize on ambient air. The channel 8 switch was then set in position 0 (range 1) or position 1 (range 2). The corresponding scale settings on the nephelometer are A/C for range 1 and B/D for range 2.

APPENDIX E

DAILY TRAILER INSPECTION, ZERO AND SPAN CHECKS, AND STATION CALIBRATION ADJUSTMENTS

Daily trailer inspection, zero and span calibrations, and station calibration adjustments, performed in that order, were control procedures continuously performed during the entire monitoring period at WAFB. The performance of these procedures was a check and cross-check of system operations in order to detect unexpected changes in the physical layout of the system or the monitoring routine that could cause loss of data acquisition time, system degradation, or poor quality data.

TRAILER INSPECTION

The first daily procedure utilized the trailer inspection checklist (Figure E-1) to review the monitor station sensors and intake manifold. This daily inspection provided input for decisions on the daily calibration activity that followed.

ZERO AND SPAN CHECKS

The second daily procedure, zero and span checks on the air monitoring instruments at all of the five stations, was performed to provide unadjusted calibration data entered on the data calibration checklist (Figure E-2) and also used to make daily adjusted calibrations to predetermined values at one station per day. These data could later be used for a conversion of voltages to concentration (engineering) units, for correcting data to account for zero and span fluctuations, and to construct control charts that were analyzed to evaluate instrument performance on a continuing basis. The order in which the five stations were checked was altered daily to avoid any bias to the collection of the data. The zero and span calibration was normally carried out by AF personnel through the following procedures: First, all the data switches except wind velocity were changed to position 9 (inoperative code). The instruments were then ready to be checked individually. The wind azimuth was placed in the zero calibrate position and the data switch for channel 7 was changed to position 4 (unadjusted zero check). The monitoring screen on the remote data logger was observed while the central data system polled five times. During each poll, the value for channel 7 was recorded on a calibration checksheet while the central system recorded the same value on magnetic tape. The wind azimuth was then switched to the span calibrate position. The wind azimuth calibrations were electronic or instrumental. The data switch for channel 7 was set to position 5 (unadjusted calibrate check).

TRAILER ___________ TIME ___________ DATE ___________

Before entering the trailer, the following should be checked:

1. Air sampling cane. OK _____ Other _____ (explain reverse side)
2. Nephelometer air intake. OK _____ Other _____ (explain reverse side)
3. Is propellor and vane responding? YES _____ NO _____
4. Any noted physical damage to outside of trailer or exposed equipment? (If yes, explain reverse side) YES _____ NO _____
5. Check clean air system for the GC. OK _____, HOT _____, NOISY _____
6. Is trailer blocking and tie down all right? YES _____ NO _____

The rest of the checks are inside the trailer.

1. Is air conditioner running? YES _____ NO _____
2. Does the roof leak in inclement weather? YES _____ NO _____
3. Check air sampling manifold for connections.
   OK _____ OTHER _____ (explain reverse side)
4. Check air sample pump. OK _____ OTHER _____ (explain reverse side)
5. Check Nephelometer pump. OK _____ OTHER _____ (explain reverse side)
6. Beckman 6800.
   a. Pressure Gauges - Hydrogen fuel ___________
      Burner air ___________
      Air carrier ___________
      Service air ___________
      Hydrogen carrier ___________
   b. Check service air water trap (back of instrument) for moisture.
   c. Memory outputs - 1. ___________
      2. ___________
      3. ___________
   d. Auto zero background reading. ___________
   e. Oven light flashing? YES _____ NO _____
   f. Catalytic converter light on? YES _____ NO _____
7. Hydrogen Generator.
   a. Is power light on? YES _____ NO _____
   b. Is generate light going on and off? YES _____ NO _____
   c. Is low water light on? YES _____ NO _____
   d. Output pressure. ___________
   e. Reservoir water level. ___________
8. Nephelometer.
   a. Is power on? YES _____ NO _____
   b. Mode switch position. ___________
   c. Scale range. ___________
   d. Is blue flasher light working? YES _____ NO _____
   e. Meter reading. ___________

Figure E-1. Trailer inspection checklist.

9. Monitor Labs 8440
    a. Inches of drierite left (approximately)? ____________
    b. Is power on? YES ______ NO ______
    c. Meter reading for NO. ____________
    d. Meter reading for NO_x. ____________
    e. NO flow meter reading. ____________
    f. NO_x flow meter reading. ____________
    g. Ozone flow meter reading. ____________
    h. Vacuum reading. ____________
    i. Range NO. ____________
    j. Range NO_x. ____________
    k. Time constant NO. ____________
    l. Time constant NO_x. ____________
    m. Function switch setting. ____________
10. Wind Speed and Direction
    a. Is power on? YES ______ NO ______
    b. Are meters reading on scale? YES ______ NO ______
    c. Are meters responding to changes? YES ______ NO ______
11. Data System
    a. Is power on? YES ______ NO ______
    b. The station is poled every minute. Observe one cycle. Did channels (00 to 16) and data appear in the readout? YES ______ NO ______
12. Does the trailer have a flashlight? YES ______ NO ______
13. Is there a spare set of batteries? YES ______ NO ______
14. Is there a pen available? YES ______ NO ______
15. Number of feet of paper left on strip chart recorder 0815 run only. ____________
16. Remove used strip chart recorder paper on 1600 run only.
17. Special checks to be made:

Completed time ____________ Date ____________ Initials ____________

Figure E-1 (continued).

TRAILER__________ TIME__________ DATE__________

DATA SWITCHES ON ENTRY

____	____	____	____	____	____	____	____	____	____
0	1	2	3	4	5	6	7	8	9

I. WIND AZIMUTH

	Unadjusted zero (4)		Unadjusted calibrate (5)
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	

II. NO-NO_x

	Unadjusted pure air (5)			Unadjusted span (6)	
	NO_x	NO		NO_x	NO
1.			1.		
2.			2.		
3.			3.		
4.			4.		
5.			5.		

III. NEPHELOMETER

	Unadjusted pure air (5)			Unadjusted calibrate (6)	
1.			1.		
2.			2.		
3.			3.		
4.			4.		
5.			5.		

IV. G.C.

Unadjusted span (4)

	Memory #1	#2	#3
1.			
2.			
3.			
4.			
5.			

DATA SWITCHES ON DEPARTURE

____	____	____	____	____	____	____	____	____	____
0	1	2	3	4	5	6	7	8	9

____
Initials

Figure E-2. Daily calibration checklist.

Five values were recorded during five polls. The wind azimuth sensor was returned to normal operation and channel 7 was returned to position 0 (normal operation).

The ML 8440 NO-NO_x analyzer was connected to ultrapure air and allowed to stabilize for 5 to 10 minutes. The data switches for channels 1 and 2 were switched to position 5 (unadjusted pure air). Five readings were recorded on the calibration checksheet while the data system polled five times. Channels 1 and 2 were also returned to position 9 (inoperative). Span gas was introduced into the sample inlet of the instrument. Another 5- to 10-minute stabilization was allowed. The data switches for both channels were either set to position 6 (unadjusted span from the calibration system) or position 7 (unadjusted span from the low concentration cylinders), depending on the particular test atmosphere, while the central data system made five scans of the channels. The channels were returned to position 9, and the sample inlet was reconnected to the sampling manifold. After a 5-minute waiting period, the data switches for channels 1 and 2 were returned to position 1 (i.e., instrument range 3, ambient air).

The MRI nephelometer was switched to pure air and allowed to purge with filtered air for 20 minutes. The data switch for channel 8 was placed in position 5 (unadjusted pure air). The data system was observed to poll five times, and five voltage values were recorded on the calibration checksheets. The data switch for channel 8 was returned to position 9. The nephelometer mode switch was switched to the calibration check position and allowed to stabilize on this value for a simulated span output. The channel 8 data switch was rotated to position 7 (unadjusted calibration check) and five values were recorded for five data system polls. The channel was then set to position 9 while the technician returned the instrument to monitoring ambient air. After the instrument had stabilized, the channel was returned to position 0 (i.e., instrument range 1, ambient air).

The Beckman 6800 gas chromatograph was connected to a test calibration gas and allowed to stabilize for at least two five-minute cycles. Then the data switches for channels 3, 4, and 5 were placed in position 4 (unadjusted span). The data system was allowed to poll the instrument for 25 scans or the time needed by the gas chromatograph for five complete cycles. Since the gas chromatograph values changed only once every 5 minutes, it was required to record one value for every five data system scans for each of the three channels on the calibration checksheet. To verify performance of the gas chromatograph memory circuits, all five values were recorded for the first five polls of the central data system. Data switches for the three channels were then placed in position 9. The instrument was switched to monitoring ambient air and allowed to cycle for 10 to 15 minutes. The data switches were then set for position 1 (i.e., normal operation with averaging bottle residence volume included).

Air Force and contractor personnel recorded all the data from the calibration sheet onto permanent logbooks that remained at the remote station. The positions on all the data switches on the calibration checksheet were also recorded.

STATION CALIBRATION ADJUSTMENTS

The daily station calibration of one station per day that followed the procedures given in Appendix D was performed by a calibration team of AF and contractor personnel. A station was not calibrated on the same day of each week, and each station was calibrated at least once in every 10 days.

Upon entering a trailer, the calibration team set the data switches on all channels of the remote data system to 9 indicating the trailer had been removed from normal ambient air sampling. The zero and span checks were first performed according to the procedures outlined above. Then adjusted calibrations were completed as follows.

Span gas was first applied to the Beckman 6800, and the instrument was allowed to stabilize. After stabilization, the ML 9400 remote data switches for CH_4, THC, and CO were placed in position 4. Five instantaneous values at 5-minute intervals were recorded automatically by the data system and manually on the calibration sheet. Data switches were then returned to 9 and the Beckman 6800 was adjusted to obtain the required calibration voltage for the desired full-scale operation range. The data switches for CH_4, THC, and CO were then placed in position 3, and five cycles of operation were again recorded to document adjustment on the magnetic tape. The data switches were then returned to 9 and the instrument returned to normal status for sampling abient air. After stabilization to ambient air was achieved, the data switches were returned to position 1 indicating normal ambient air sampling.

Simultaneous with calibration of the Beckman 6800, calibration was applied to the sample input of the ML 8440 NO/NO_x instrument allowing it to condition and stabilize. The data switches were then placed in position 5 and five one-minute values were recorded. The data switches were then turned to 9 and a span gas was applied to the ML 8440 sample input. Again the instrument was allowed to stabilize and the data switches were placed in position 7. Five values were recorded after which the data switches were again returned to 9. The above procedure was then repeated with zero and span adjusted to predetermined values and data switches 2 and 4 used rather than 5 and 7, indicating an adjusted zero and span. The sample inlet was then connected to the manifold system, and after stabilization the data switches for NO/NO_x were instrumentally switched from 9 to 1, indicating an operational system collecting ambient air samples.

Pure air was introduced into the nephelometer and the instrument was allowed to stabilize utilizing the above switch settings. The data switch for the nephelometer was placed in position 5 and five one-minute values were recorded. The instrument was then placed in the calibrate mode and allowed to stabilize. The data switch for the nephelometer was placed in positon 7 and five one-minute values were recorded. Pure air was again introduced into the nephelometer, and after stabilization the pure air point was adjusted to the scattering coefficient of pure air. The data switch for the nephelometer was then placed in position 2, and five one-minute values were recorded. Freon was then introduced into the nephelometer, and after stabilization the span was adjusted to the scattering coefficient of Freon. The data switch was placed in position 3, the five values were recorded, and the data switch was returned to position 9. Again the nephelometer was placed in the calibrate mode and allowed to stabilize. The data switch was placed in position 4, and five one-minute values were recorded to document adjustment, after which the data switch was returned to position 9. The nephelometer was then returned to sampling ambient air and allowed to stabilize. The data switch was finally placed in 0 indicating an operational system.

The calibration values were recorded in logbooks provided for each individual instrument.

APENDIX F

CODING FOR DATA SWITCHES (THUMBWHEELS) OF THE DATA LINKS AT MONITORING STATIONS

The monitoring stations were linked to the central data acquisition system through telephone lines to the ML Model MDM-300L, 700 baud modem, the Model 15C-2 internal system controller, the Model 7000R main frame, and the Model KVS 10-channel input.

The results of normal monitoring operations were relayed to the central data acquisition system by use of the data switches in the remote ML 9400 data link, read in order on the frame from left to right. Data switch (thumbwheel) coding was as follows:

Data Switch 1: NO

0 - Range 2

1 - Range 3

2 - Adjusted pure air

3 - Adjusted span from calibration system

4 - Adjusted span from low-concentration cylinder

5 - Unadjusted pure air

6 - Unadjusted span from calibration system

7 - Unadjusted span from low-concentration cylinders

8 - Change in operating parameters or conditions to be recorded in the logbook

9 - Inoperative

Data Switch 2: NO_x

0 - Range 2

1 - Range 3

2 - Adjusted pure air

3 - Adjusted span from calibration system

4 - Adjusted span from low-concentration cylinder

5 - Unadjusted pure air

6 - Unadjusted span from calibration system

7 - Unadjusted span from low-concentration cylinders

8 - Change in operating parameters or conditions to be recorded in the logbook

9 - Inoperative

Data Switch 3: CH_4

0 - Normal operation without averaging bottle

1 - Normal operation with averaging bottle

2 - Zero air check

3 - Adjusted span

4 - Unadjusted span

8 - Change in operating parameters or conditions to be recorded in the logbook

9 - Inoperative

Data Switch 4: THC

0 - Normal operation without averaging bottle

1 - Normal operation with averaging bottle

2 - Zero air check

3 - Adjusted span

4 - Unadjusted span

8 - Change in operating parameters or conditions to be recorded in the logbook

9 - Inoperative

Data Switch 5: CO

0 - Normal operation without averaging bottle

1 - Normal operation with averaging bottle

2 - Zero air check

3 - Adjusted span

4 - Unadjusted span

8 - Change in operating parameters or conditions to be recorded in the logbook

9 - Inoperative

Data Switch 6: Wind Speed

0 - Normal operation

1 - Adjusted zero

2 - Adjusted span

3 - Unadjusted zero

4 - Unadjusted span

8 - Change in operating parameters or conditions to be recorded in the logbook

9 - Inoperative

Data Switch 7: Wind Azimuth

0 - Normal operation

1 - Adjusted zero check

2 - Adjusted calibration check

3 - Adjusted 180° calibration check

4 - Unadjusted zero check

5 - Unadjusted calibration check

6 - Unadjusted 180° calibration check

8 - Change in operating parameters or conditions to be recorded in the logbook

9 - Inoperative

Data Switch 8: Nephelometer

0 - Range 1

1 - Range 2

2 - Adjusted pure air

3 - Adjusted Freon check

4 - Adjusted calibration check

5 - Unadjusted pure air

6 - Unadjusted Freon check

7 - Unadjusted calibration check

8 - Change in operating parameters or conditions to be recorded in the logbook

9 - Inoperative

Data Switch 0: Station number of special functions

APPENDIX G

LISTS OF SECONDARY CALIBRATION GASES AND THEIR LOCATIONS AND DATES OF USE AT WAFB

Air monitoring calibration gases that are relatively nonreactive (CO, CH_4) are available from manufacturers at high levels of concentration. Agreement on concentration among vendors' cylinders has been achieved only recently, partially because these gases were only recently available from the NBS. Availability at lower concentrations is very limited.

Cylinders of gases used to produce test atmospheres for calibration activity were obtained with certified analyses of concentration. Upon receipt of the gases, the vendor analysis was verified by cross-comparison to local gas standards, and the gases were subsequently cross-compared and analyzed at secified intervals to check for changes in concentration. The list of calibration gases, their use at each location, and dates of use are included in this appendix.

A van with a wheeled cart containing the dilution calibration system was used to deliver test and calibration atmospheres at different concentrations for the NO/NO_x analyzer at each station. The van transported the Bendix Model 8851X Dynamic Calibration System (BDCS), the AADCO Model 737 zero air generator, calibration gas cylinders (NO/NO_x and CO/CH_4), and compressors with silencer housing from site to site (Figure G-1).

NITRIC OXIDE SECONDARY CALIBRATION GAS STANDARDS USED IN TRAILERS FOR EACH MONITORING STATION CALIBRATION PERIOD

ML 8440 Span Concentrations for NO†

Trailer 1	Cylinder No.	NO (ppm)**
June 1, 1976, through September 9, 1976	BDCS*	
September 10, 1976, through December 4, 1976	CC1048	0.34
December 5, 1976, through December 12, 1976	CC1067	0.10
December 13, 1976, through June 1, 1977	CC1315	0.34
June 2, 1977, through June 30, 1977	CC1301	0.15

---

* BDCS on ML 8440 used between 6/1/76 and 9/9/76 to calibrate various gas concentrations based on flow rate. Values for this period using BDCS are presented in the section following this data.

** All stated values are ± 2 percent except as otherwise noted.

† Manufacturer's stated value

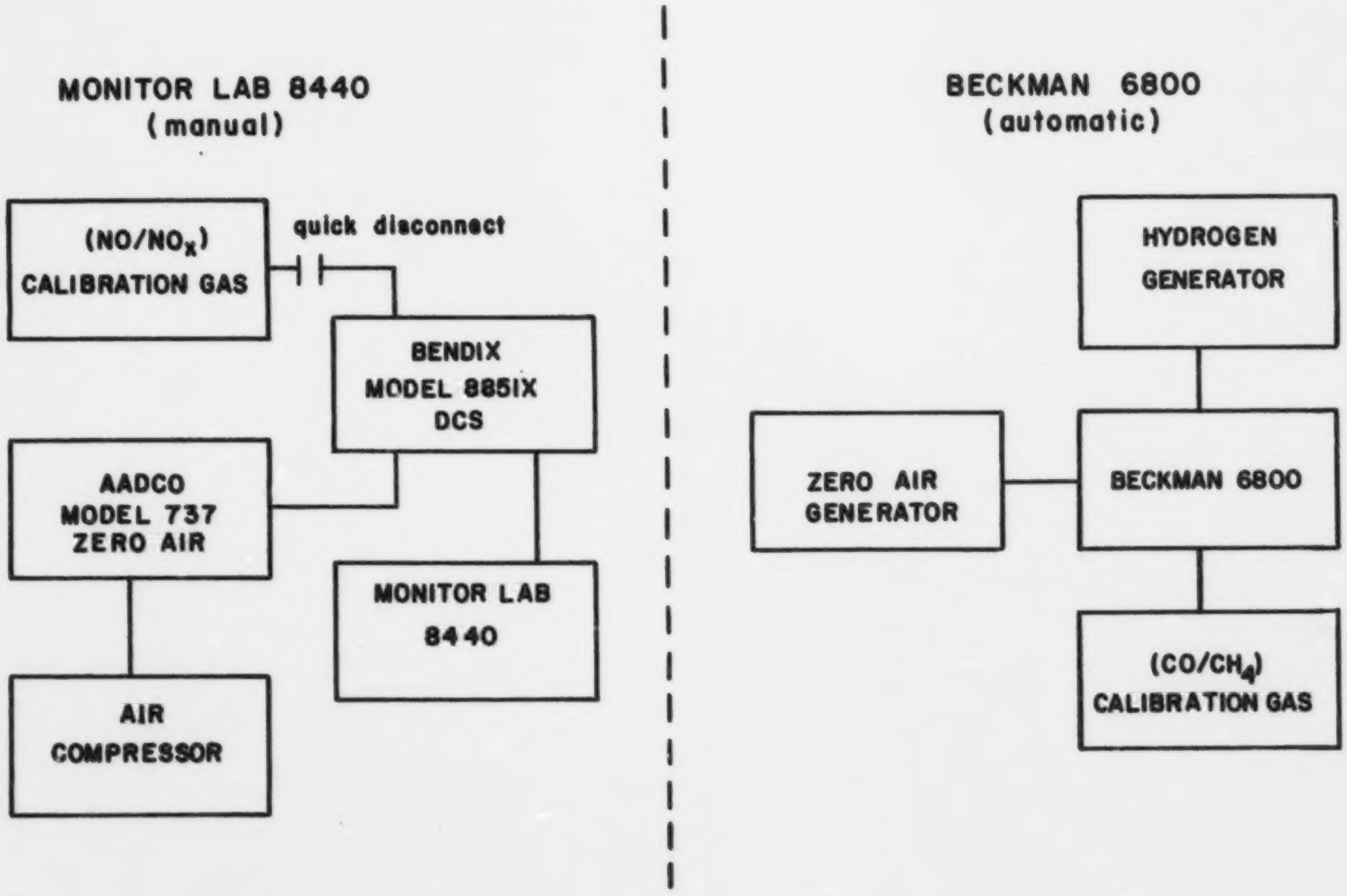
MONITOR LAB 8440
(manual)
(NO/NO$_x$)
CALIBRATION GAS
quick disconnect
BENDIX
MODEL 8851X
DCS
AADCO
MODEL 737
ZERO AIR
MONITOR LAB
8440
AIR
COMPRESSOR
BECKMAN 6800
(automatic)
HYDROGEN
GENERATOR
ZERO AIR
GENERATOR
BECKMAN 6800
(CO/CH$_4$)
CALIBRATION GAS

Figure G-1. Calibration system for air quality trailers.

Trailer 2

June 1, 1976, through September 9, 1976	BDCS*	
September 10, 1976, through December 12, 1976	CC1266	0.40
December 13, 1976, through June 1, 1977	CC1302	0.28
June 2, 1977, through June 30, 1977	CC1314	0.49

Trailer 3

June 1, 1976, through September 9, 1976	BDCS*	
September 10, 1976, through December 14, 1976	CC1071	0.33
December 15, 1976, through April 13, 1977	CC1299	0.29
April 14, 1977, through June 30, 1977	CC1316	0.24

Trailer 4

June 1, 1976, through September 9, 1976	BDCS*	
September 10, 1976, through December 15, 1976	CC1262	0.42
December 16, 1976, through March 17, 1977	CC699	0.26
March 18, 1977, through June 1, 1977	CC1309	0.40
June 2, 1977, through June 30, 1977	CC1309	0.37

Trailer 5

June 1, 1976, through September 9, 1976	BDCS*	
September 10, 1976, through December 12, 1976	CC1264	0.40
December 13, 1976, through June 1, 1977	CC1317	0.30
June 2, 1977, through June 15, 1977	CC1317	0.26
June 16, 1977, through June 27, 1977	CC1315	0.34
June 28, 1977, through June 30, 1977	CC1302	0.19

ML 8440 SPAN CONCENTRATIONS USING BDCS FOR JUNE 1, 1976, THROUGH SEPTEMBER 9, 1976

June 1, 1976, through June 17, 1976

Used BDCS Ser. No. 300883-2 with B/C gauge settings of 80/30
Matheson cylinder RR47059 with concentration of 63 ppm NO in N_2
Corrected flows: "B" = 10.72 cm^3/min "C" = 1518 cm^3/min

$$\text{Span concentration} = \frac{63 \times 10.72}{1518 + 10.72} = 0.44 \text{ ppm}$$

June 18, 1976, through June 21, 1976

Used BDCS Ser. No. 300883-2 with B/C gauge settings of 70/30
Matheson cylinder RR25289 with concentration of 76 ppm NO in N_2
Corrected flows: "B" = 8.98 cm^3/min "C" = 1518 cm^3/min

$$\text{Span concentration} = \frac{76 \times 8.98}{1518 + 8.98} = 0.45 \text{ ppm}$$

June 22, 1976, through August 27, 1976

Used BDCS Ser. No. 300883-1 with B/C gauge settings of 70/40
Matheson cylinder RR25289 with concentration of 76 ppm NO in N_2
Corrected flows: "B" = 7.69 cm^3/min "C" = 1400 cm^3/min

$$\text{Span concentration} = \frac{76 \times 7.69}{1400 + 7.69} = 0.42 \text{ ppm}$$

August 28, 1976, through September 1, 1976

Used BDCS Ser. No. 300883-1 with B/C gauge settings of 80/40
Airco cylinder LL1352 with concentration of 58.5 ppm NO in N_2
Corrected flows: "B" = 9.55 cm^3/min "C" = 1400 cm^3/min

$$\text{Span concentration} = \frac{58.5 \times 9.55}{1400 + 9.55} = 0.40 \text{ ppm}$$

September 2, 1976, through September 9, 1976

Used BDCS Ser. No. 300883-1 with B/C gauge settings of 85/30
Airco cylinder LL1352 with concentration of 58.5 ppm NO in N_2
Corrected flows: "B" = 7.42 cm^3/min "C" = 1010 cm^3/min

$$\text{Span concentration} = \frac{58.5 \times 7.42}{1010 + 7.42} = 0.43 \text{ ppm}$$

CROSS-COMPARISONS OF AIRCO LOW-CONCENTRATION CYLINDERS

1st Cross-Commparison - September 10, 1976

Cylinder No.	Location	NO(ppm)	Volts	NO_x(ppm)	Volts	Airco Original Analysis
CC1262*	Trailer 4	0.42	0.84	0.42	0.84	0.45
CC1048	Trailer 1	0.34	0.68	0.34	0.68	0.41
CC1266	Trailer 2	0.40	0.80	0.40	0.80	0.43
CC1071	Trailer 3	0.33	0.66	0.33	0.66	0.41
CC1264	Trailer 5	0.405	0.81	0.405	0.81	0.44
CC1067	Building 16	0.12	0.24	0.12	0.24	0.125

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* Secondary standard evaluation:

Analysis performed at trailer 2 on ML 8440 for cross-comparison:
Cylinder No. CC1262 analyzed by Conoco at 0.41 ppm, September 7, 1976
Cylinder No. CC1262 analyzed by Phelps Dodge at 0.40 ppm, September 9, 1976

Concentration value =

$$\frac{\text{Phelps Dodge conc.} + \text{Airco conc.} + \text{Conoco conc.}}{3} = 0.42 \text{ ppm}$$

2nd Cross-Comparison - November 5, 1976

Cylinder No.	Location	NO(ppm)	Volts	NO_x(ppm)	Volts	Sept. 10 Value
CC1262*	Trailer 4	0.42	2.54	0.42	2.54	0.42
CC1048	Trailer 1	0.33	1.95	0.33	1.95	0.34
CC1266	Trailer 2	0.41	2.45	0.41	2.45	0.40
CC1071	Trailer 3	0.30	1.78	0.30	1.78	0.33
CC1264	Trailer 5	0.40	2.40	0.40	2.41	0.41
CC1067	Building 16	0.11	0.65	0.11	0.65	0.12

---

* Secondary standard (see cross-comparison 1)
Tests performed at trailer #3 on ML 8440 Ser. No. 214 for cross-comparison

3rd Cross-Comparison - December 15, 1976

Cylinder	Location	NO(ppm)	Volts	NO_x(ppm)	Volts
CC1071	Trailer 3	0.28	2.67	2.69	2.69
CC1316	Building 16	0.31	2.99	0.31	3.01
CC1299	Trailer 3a	0.29	2.79	0.29	2.79
CC1302	Trailer 2a	0.28	2.72	0.28	2.73
CC1317	Trailer 5a	0.30	2.91	0.30	2.90
CC1315	Trailer 1a	0.34	3.30	0.34	3.30
CC699	Trailer 4a	0.26	2.47	0.26	2.47
CC1301	Building 16	0.21	2.02	0.21	2.02
CC1067	Building 16	0.10	0.98	0.10	0.98
CC1262*	Trailer 4	0.42	4.05	0.42	4.05
CC1309	Building 16	0.40	3.88	0.40	3.88
CC1264	Trailer 5	0.40	3.82	0.40	3.82
CC1048	Trailer 1	0.32	3.08	0.32	3.08
CC1266	Trailer 2	0.41	4.00	0.41	4.00
CC1071	Trailer 3	0.27	2.66	0.27	2.68

---

* Secondary standard (see cross-comparison 1)
Analysis performed at trailer 3 on ML 8440 Ser. No. 214 for cross-comparison

4th Cross-Comparison - June 1, 1977

Cylinder	Location	NO(ppm)	Volts	NO_x(ppm)	Volts
CC1314	Trailer 2b	0.49	3.50	0.49	3.50
CC1301	Trailer 1b	0.15	1.06	0.15	1.04
CC1317	Trailer 5a	0.26	1.84	0.26	1.81
CC1309	Trailer 4b	0.37	2.63	0.37	2.60
CC1067*	Building 16	0.08	0.59	0.08	0.59
CC1316*	Trailer 3b	0.24	1.71	0.24	1.72
CC1315	Trailer 1a	0.34	2.40	0.34	2.38
CC1302	Trailer 2a	0.21	1.46	0.21	1.44

---

* Analyzed in Las Vegas against NBS SRM FF2546 in February 1977. These cylinders certified as secondary standards (results as indicated):

CC1067 NO = 0.08 ppm
CC1316 NO = 0.24 ppm

Also analyzed by NSI-RTP in August 1977 (results as indicated):

CC1067 NO = 0.075 ppm
CC1316 NO = 0.22 ppm

Analysis performed at trailer 2 on ML 8440 Ser. No. 248 for cross-comparison

METHANE AND CARBON MONOXIDE SECONDARY CALIBRATION GAS STANDARDS USED IN TRAILERS FOR EACH MONITORING STATION CALIBRATION PERIOD

Beckman 6800 Span Gas Cylinders Used for CH_4 and CO

	Cylinder No.	CH_4 (ppm)	CO (ppm)
Trailer 1			
June 1, 1976, through November 17, 1976	L2306	5.07*	4.95*
November 18, 1976, through December 17, 1976	L2276	5.15	5.02
December 18, 1976, through June 30, 1977	CC279	3.03	3.03

Trailer 2			
June 1, 1976, through September 22, 1976	L2274	5.14	5.02
September 23, 1976, through March 7, 1977	MM9940	4.98±5%	5.02 ±5%
March 18, 1977, through June 30, 1977	CC369	3.02	3.03
Trailer 3			
June 1, 1976, through December 23, 1976	L2271	5.11	4.98
December 24, 1976, through February 23, 1977	CC370	3.02	3.04
February 24, 1977, through June 30, 1977	CC367	3.02	3.04
Trailer 4			
June 1, 1976, through September 22, 1976	L2276	5.14	5.02
September 23, 1976, through January 2, 1977	L2277	5.13	5.04
January 3, 1977, through June 30, 1977	CC278	3.02	3.03
Trailer 5			
June 1, 1976, through September 22, 1976	L2278	5.07±5%	4.97±5%
September 23, 1976, through January 2, 1977	L2334	4.93	5.00
January 3, 1977, through June 30, 1977	CC364	3.02	3.03

* Stated values are ± 2 percent except as noted otherwise.

CROSS-COMPARISONS OF SCOTT-MARRIN CONCENTRATION CYLINDERS

The following procedure was utilized for cross-comparison of CH_4/CO standards.

- September 23, 1976.

  Eight nominal 5 ppm CO/CH_4 gas cylinders were moved to trailer 5 to be cross-checked on the Beckman 6800. The cylinder numbers were L2306, L2274, L2271, L2276, L2334, MM9940, and L2277.

  Before cross-comparing the cylinders, the trailer 5 gas chromatograph was calibration-checked using the span cylinder (12278) that was routinely used for calibration checks in this trailer. The previous week's calibration values were reviewed to determine if the instruments were performing satisfactorily. Since the calibration was very close to the desired span of 2 ppm/V, no adjustments were made to the gas chromatograph.

  All of the eight cylinders were then analyzed on the gas chromatograph and the voltage outputs recorded. Since no absolute standard was available at this time, the concentrations listed on page 194 are Scott Marrin's analysis, except for cylinder MM9940. MM9940 (which had a ±5% analysis and did not agree with the seven other cylinders having a ±2% analysis) was assigned a new concentration value by averaging all the other cylinder values and their voltages to determine the average ppm/V and using that value to determine the concentration for MM9940, based on its voltage response.

- December 23, 1976.

  This cross-comparison was performed on the gas chromatograph in trailer 1. As before, all the cylinders were moved to this trailer and analyzed the same day. The gas chromatograph was not adjusted but was calibration-checked before performing the cross-comparison. This gas chromatograph (as well as those in all the trailers) was being calibrated weekly and calibration-checked daily, so there was no real need to perform an additional calibration if the instrument was operating properly.

  The concentrations listed on page 195 were used; all are results of Scott-Marrin's analyses, since there was no higher order standard available at that time.

- October 23, 1977.

  The third cross-comparison was performed on October 23, 1977. The monitoring network had been shut down since June 30, 1977. It was therefore necessary to restart the gas chromatograph from trailer 4 to perform this cross-comparison. This was done using CC278, and all the cylinders were analyzed during the same day as before. CC278 was repeated at the end of the comparison to show there had been no significant span change during the tests.

  The results listed are the manufacturer's concentration values along with the voltage responses from the gas chromatograph. All the cylinders had been certified by the manufacturer to ±2% except MM9941 which was a ±5% analysis.

1st Cross-Comparison - September 23, 1976

Cylinder	Location	THC(ppm)	Volts	CH_4(ppm)	Volts	CO(ppm)	Volts
L2306	Trailer 1	5.07	2.59	5.07	2.55	4.95	2.50
L2274	Trailer 2	5.14	2.60	5.14	2.58	5.02	2.53
L2271	Trailer 3	5.11	2.58	5.11	2.56	4.98	2.53
L2276	Trailer 4	5.14	2.59	5.14	2.57	5.02	2.53
L2278*	Trailer 5	5.07	2.55	5.07	2.56	4.97	2.49
L2334	Trailer 5a	4.93	2.52	4.93	2.49	5.00	2.53
MM9940	Trailer 2a	4.98	2.51	4.98	2.51	5.02	2.54
L2277	Trailer 4a	5.13	2.58	5.13	2.60	5.04	2.57

---

* L2278, CH_4 5.06 ppm and CO 4.65 pm (± 9%), Las Vegas analysis, April 22, 1977, (cylinder pressure 500 lb/in^2)

Secondary standard evaluation (traceability)
Analysis performed at trailer 5 with Beckman 6800 gas chromatograph for cross-comparison

2nd Cross-Comparison - December 23, 1976

Cylinder	Location	THC(ppm)	Volts	CH_4(ppm)	Volts	CO(ppm)	Volts
CC279	Trailer 1a	3.03	1.51	3.03	1.49	3.03	1.44
CC367	Building 16	3.02	1.50	3.02	1.51	3.04	1.45
CC370	Trailer 3a	3.02	1.51	3.02	1.50	3.04	1.45
CC369*	Trailer 2b	3.02	1.53	3.02	1.50	3.04	1.45
CC364	Trailer 5b	3.02	1.52	3.02	1.51	3.03	1.43
CC278	Trailer 4b	3.02	1.52	3.02	1.51	3.03	1.42
CC371	Building 16	4.17	2.06	4.17	2.04	4.15	2.03
CC355	Building 16	5.14	2.55	5.14	2.54	5.14	2.57
L2276	Trailer 4	5.14	2.56	5.14	2.54	5.02	2.56

---

* CC369, CH_4 3.04 ppm and CO 3.09 ppm, RTP, North Carolina, analysis, (August 1977).
Analysis performed at trailer 1 on Beckman 6800 gas chromatograph

3rd Cross-Comparison - October 25, 1977

Cylinder	Location	THC(ppm)	Volts	CH_4(ppm)	Volts	CO(ppm)	Volts
CC278	Trailer 4b	3.02	1.51	3.02	1.50	3.03	1.52
MM9941	Building 16	4.9 *	2.48	4.9 *	2.46	4.9 *	2.48
CC367	Trailer 3b	3.02	1.50	3.02	1.50	3.04	1.51
CC279	Trailer 1a	3.03	1.51	3.03	1.50	3.03	1.51
CC364	Trailer 5b	3.02	1.50	3.02	1.48	3.03	1.49
CC278	Trailer 4b	3.02	1.51	3.02	1.49	3.03	1.50

---

* MM9941, CH_4 4.9 ppm and CO 4.9 ppm, March 24, 1976, manufacturer's original analysis ± 5%
MM9941, CH_4 4.96 ppm and CO 4.81 ppm, April 22, 1977, Las Vegas analysis
MM9941, CH_4 4.99 ppm and CO 5.02 ppm, March 14, 1978, NSI, Las Vegas analysis performed at trailer 4 on Beckman 6800 gas chromatograph

APPENDIX H

HOURLY AVERAGES AND TIME SERIES PLOTS OF WILLIAMS AIR FORCE BASE DATA

This appendix consists of hourly averages and corrected 1-minute data plotted versus time. Hourly averages of CO, NO, NO_x, and NMHC concentrations in parts per million by volume are shown in this appendix beginning with Figure H-1. Nephelometer data in units of $10^{-4}m^{-1}$ follow NMHC data. WS in meters per second and WD in degrees (0-352°) follow nephelometer data. The same order for all five monitoring stations is presented in Figures H-1 through H-91. Where there is insufficient data to calculate hourly averages, no tracing appears for that time period.

ATYPICAL EPISODES

One-minute graphical displays selected to demonstrate air quality concentrations in a 24-hour period are shown for four days of the monitoring period in Figures H-92 through H-134. The concentration scale in appropriate units is shown on the ordinate in the range needing description. Time is shown on the abscissa.

Observations were made from these data which support an indication of sources of NO_x, NMCH, and CO upwind of Williams AFB under specific meteorological conditions. Concentrations plotted for one day under atypical meteorological conditions show how sources in areas surrounding the airbase could influence air quality at the base.

Assuming the diurnal wind pattern is representative for the Phoenix valley area, background air quality at WAFB is influenced by average air motion, dispersion, and sources of pollution in the area surrounding the airbase. Mixing depth in the lower regions in the atmosphere of the valley is also a major factor, which correlates to time of day and influences pollution dispersion with respect to average air motion.

The specific data shown here have been used to demonstrate that data evaluation must be done for particular meteorological conditions. These data also show that highest concentrations recorded at WAFB are due to infrequent calm or low WS conditions.

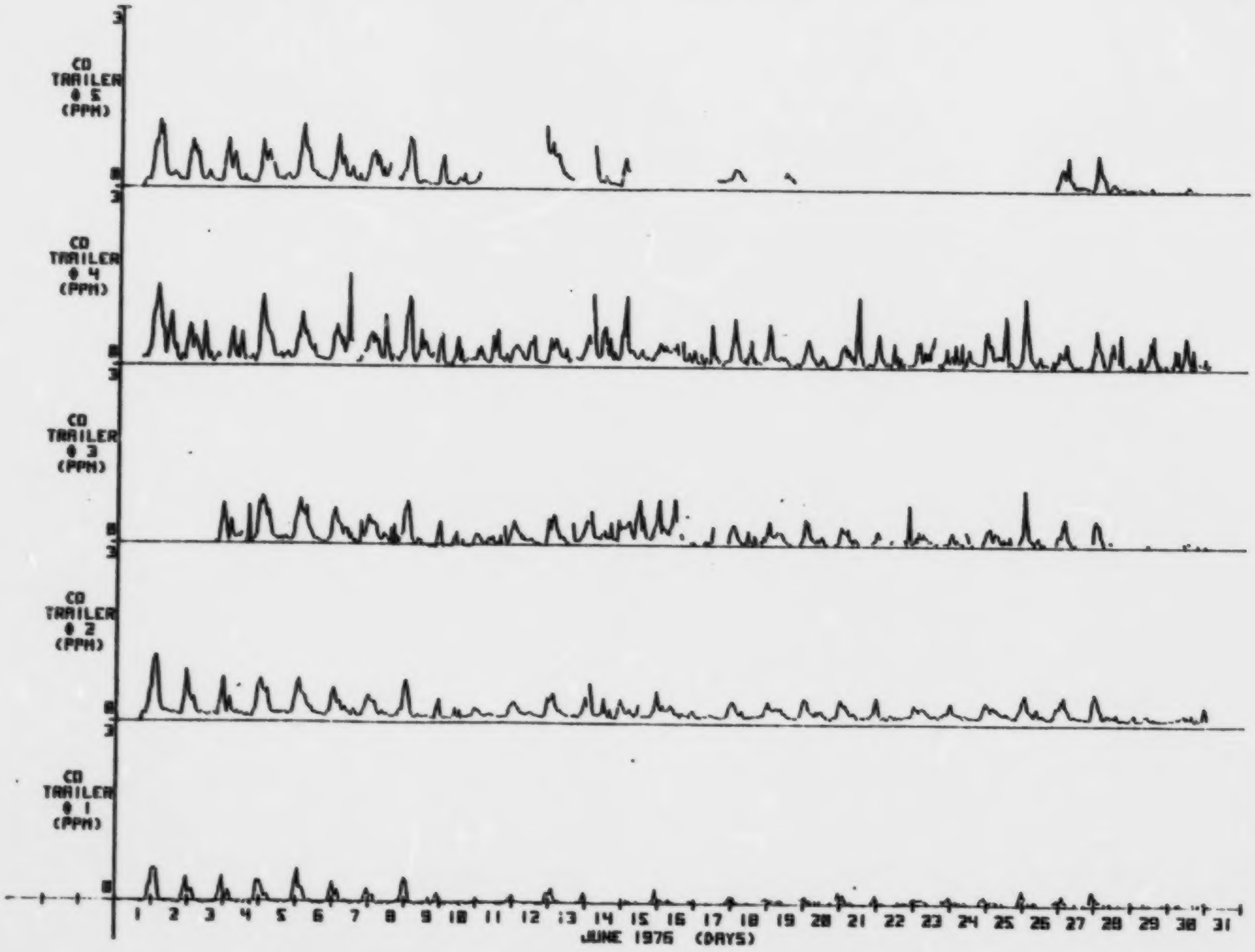
For an example, starting on September 26, 1976, WS was less than 3 m/s and the typical diurnal pattern of WD did not occur for three days. Air motion was slight to stagnant, and a gradual buildup of CO and NO_x from sources outside the airbase could have occurred (Figures H-92 through H-101). NMHC concentrations are shown in Figures H-100 and H-101. Preliminary analysis of these data indicates that NMHC at station 3 is probably related to aircraft events, and elevated concentrations over normal levels are probably due to minimum dispersion conditions at the time.

On December 29, 1976, high concentrations of NO, NO_x, NMHC, and CO were observed at all stations in the late afternoon. Again, wind speed had been low for two or more days, probably alllowing buildup around Phoenix (Figures H-102 to H-114). WD was from the northwest, starting about 1200 hours. All air quality levels increased abruptly about 4 hours later, suggesting that an air parcel containing elevated levels of pollution moved into the WAFB area and out by about midnight. Nephelometer b_{scat}, not shown in this example, was also recorded at high levels.

January 27, 1977, showed an excursion due to a meteorological condition reversed from the December 29 afternoon situation. The WD had been from the northwest for about 12 hours at low wind speeds the preceding day (Figures H-115 throught H-118). Note that CO and NMHC levels are always higher at station 4 than at station 5 since other airbase activity is recorded at higher levels at station 4, and concentrations return to near normal background levels much more quickly at the outlying stations 1, 2, 3, and 5.

On May 11, 1977 (day 131), WS had been low for about 24-26 hours. Wind direction veered from south to north over the 24-hour period on this day. NO was low while NO_x, CO, and NMHC began an abrupt rise in concentration about 2100 hours, which continued until midnight and then began decreasing (Figures H-119 through H-134). CO at station 3 was expanded (hours 1200 through 1400) to show short-term excursions where taxiing aircraft are most likely to be detected while in transit to takeoff.

The concentrations shown here have been used to demonstrate that data evaluation for WAFB must be correlated to a particular meteorological condition. These data also show that highest concentrations recorded at WAFB result from infrequent calm or low WS conditions.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CO TRAILER # 4 (PPM)
CO TRAILER # 3 (PPM)
CO TRAILER # 2 (PPM)
CO TRAILER # 1 (PPM)
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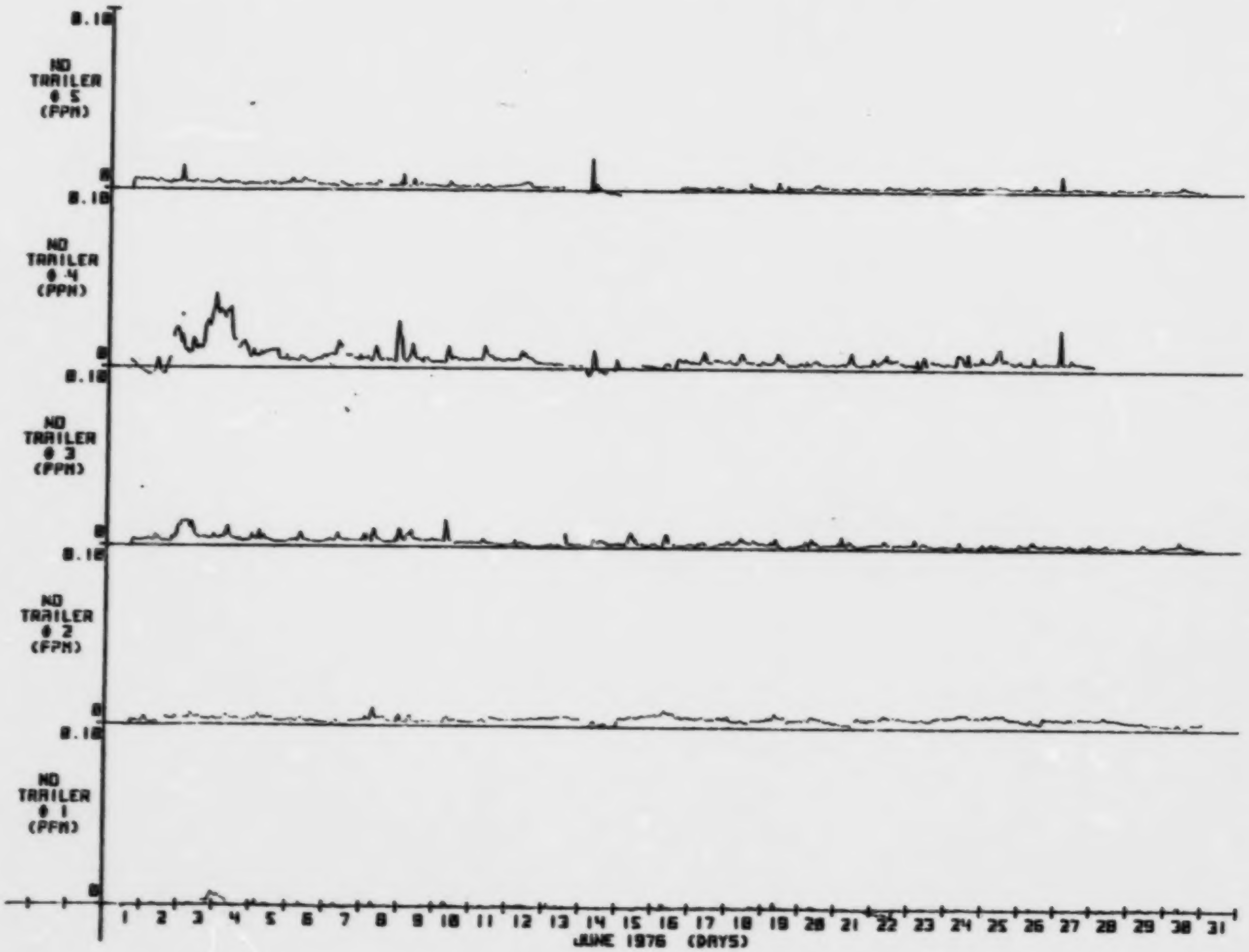
JUNE 1976 (DAYS)

Figure H-1.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0.10
NO TRAILER # 4 (PPM)
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0.10
NO TRAILER # 3 (PPM)
0
0.10
NO TRAILER # 2 (PPM)
0
0.10
NO TRAILER # 1 (PPM)
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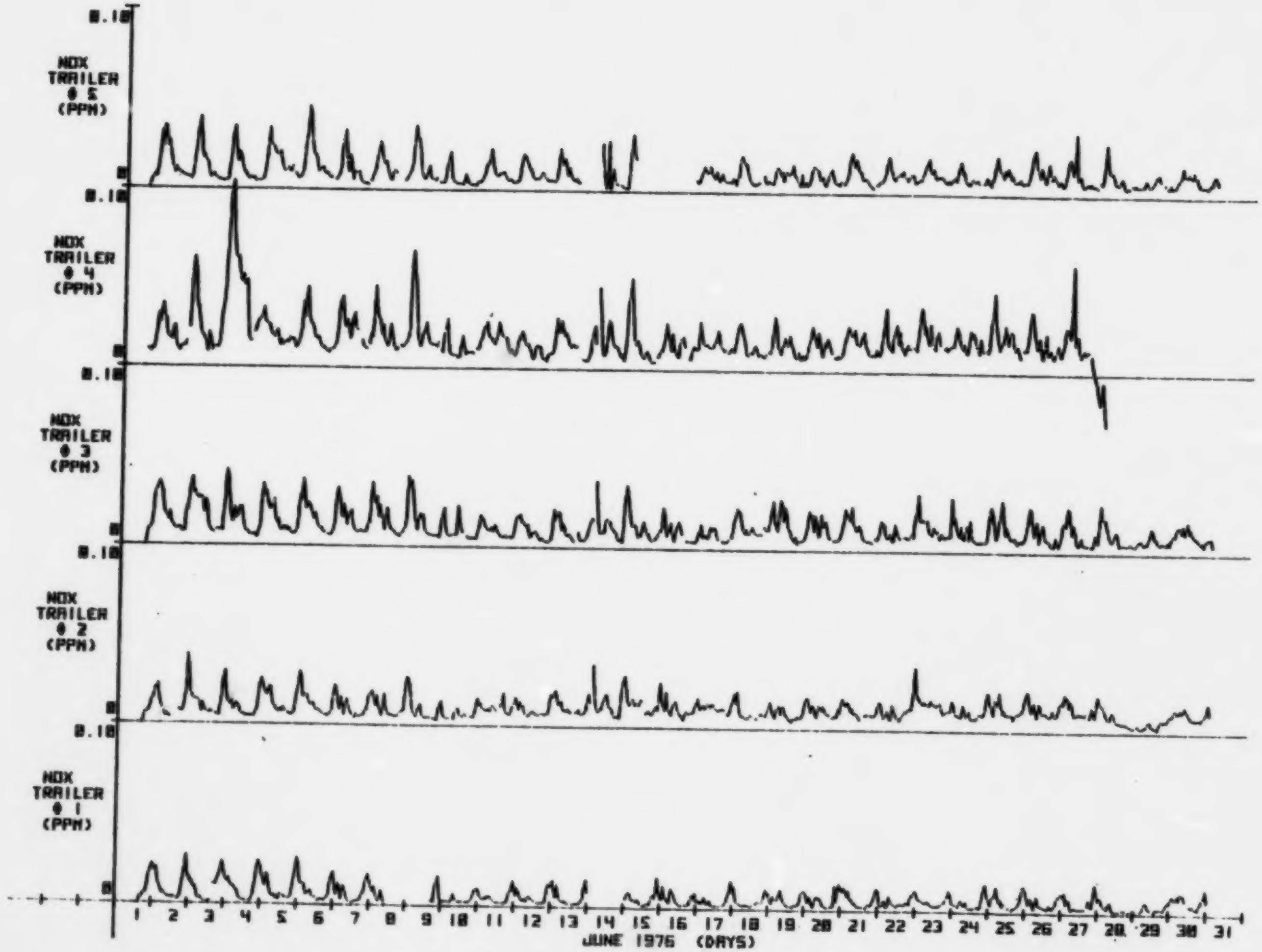
JUNE 1976 (DAYS)

Figure H-2.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0.10
NOX TRAILER # 4 (PPM)
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0.10
NOX TRAILER # 3 (PPM)
0
0.10
NOX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
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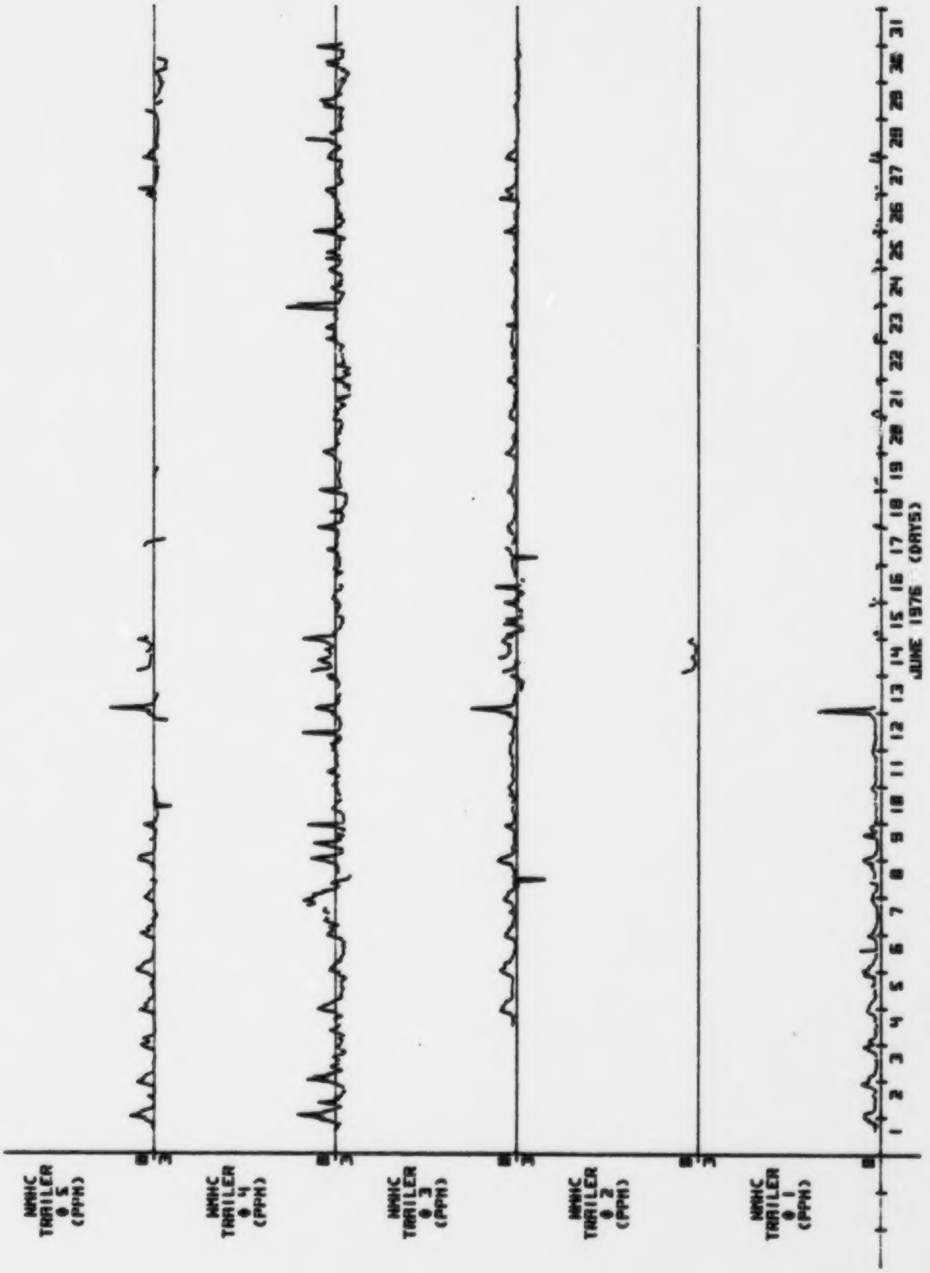
JUNE 1976 (DAYS)

Figure H-3.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NMHC TRAILER # 4 (PPM)
NMHC TRAILER # 3 (PPM)
NMHC TRAILER # 2 (PPM)
NMHC TRAILER # 1 (PPM)
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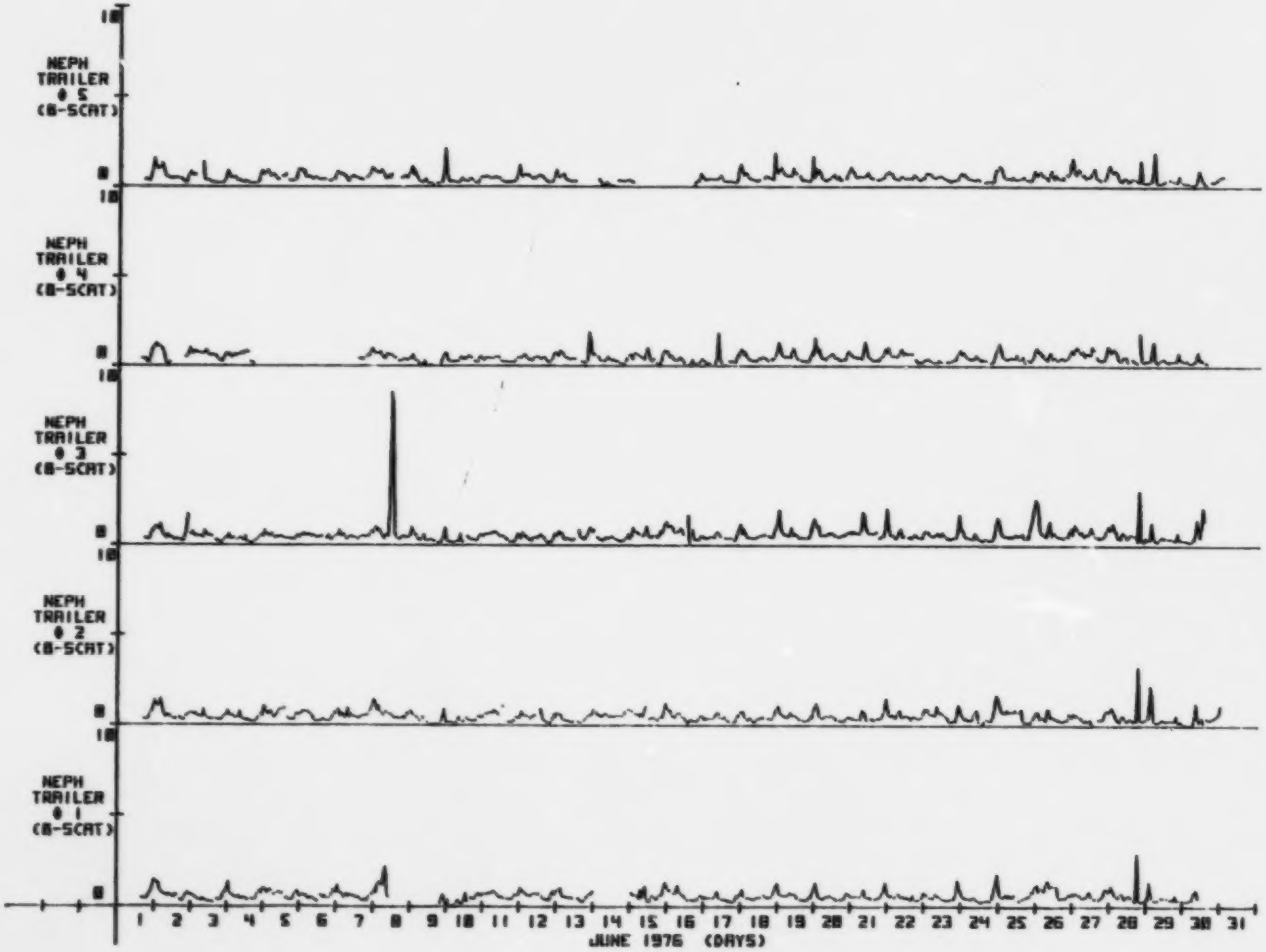
JUNE 1976 (DAYS)

Figure H-4.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# 5
(B-SCAT)
0
10
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TRAILER
# 4
(B-SCAT)
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NEPH
TRAILER
# 3
(B-SCAT)
0
10
NEPH
TRAILER
# 2
(B-SCAT)
0
10
NEPH
TRAILER
# 1
(B-SCAT)
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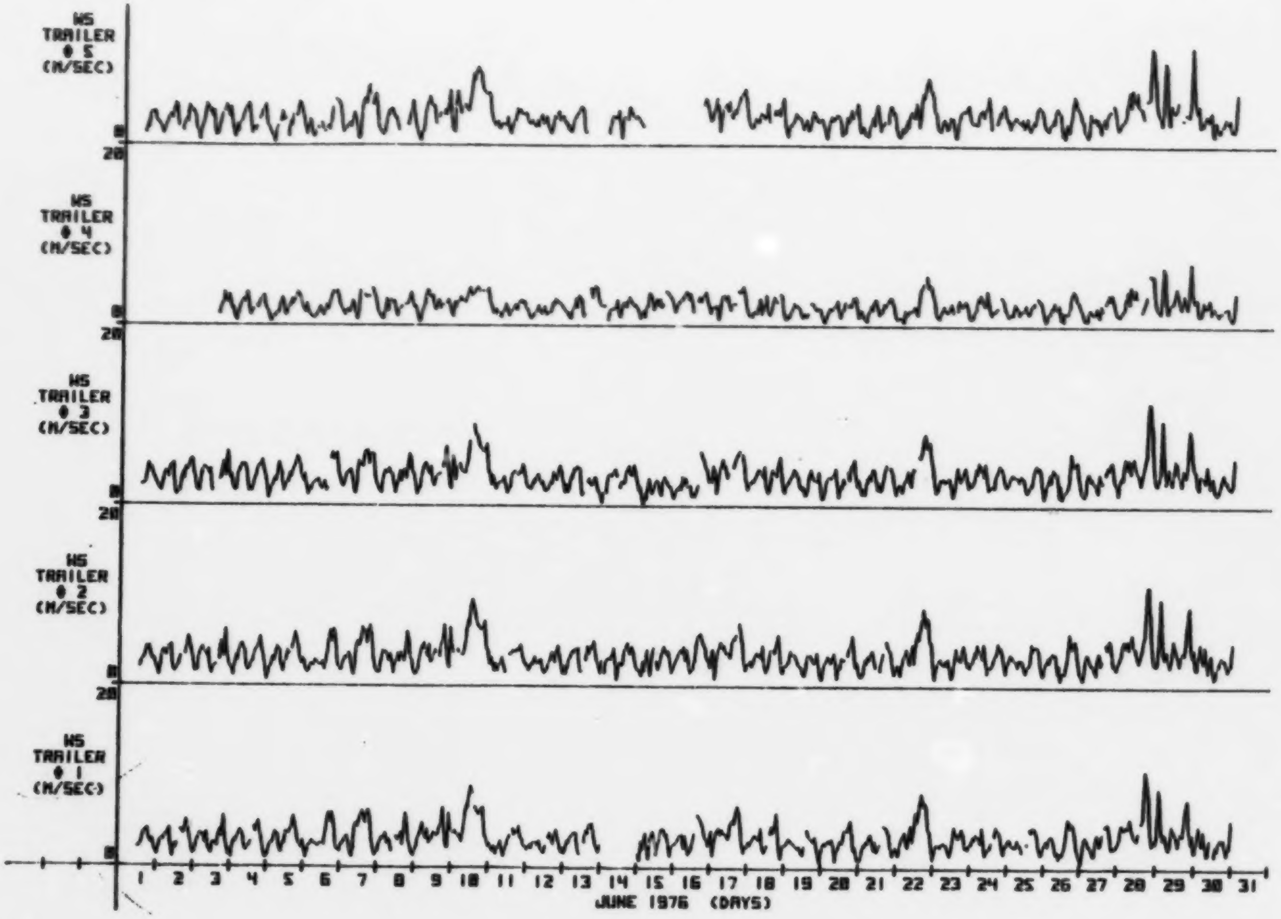
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JUNE 1976 (DAYS)

Figure H-5.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WS TRAILER # 4 (M/SEC)
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20
WS TRAILER # 3 (M/SEC)
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20
WS TRAILER # 2 (M/SEC)
0
20
WS TRAILER # 1 (M/SEC)
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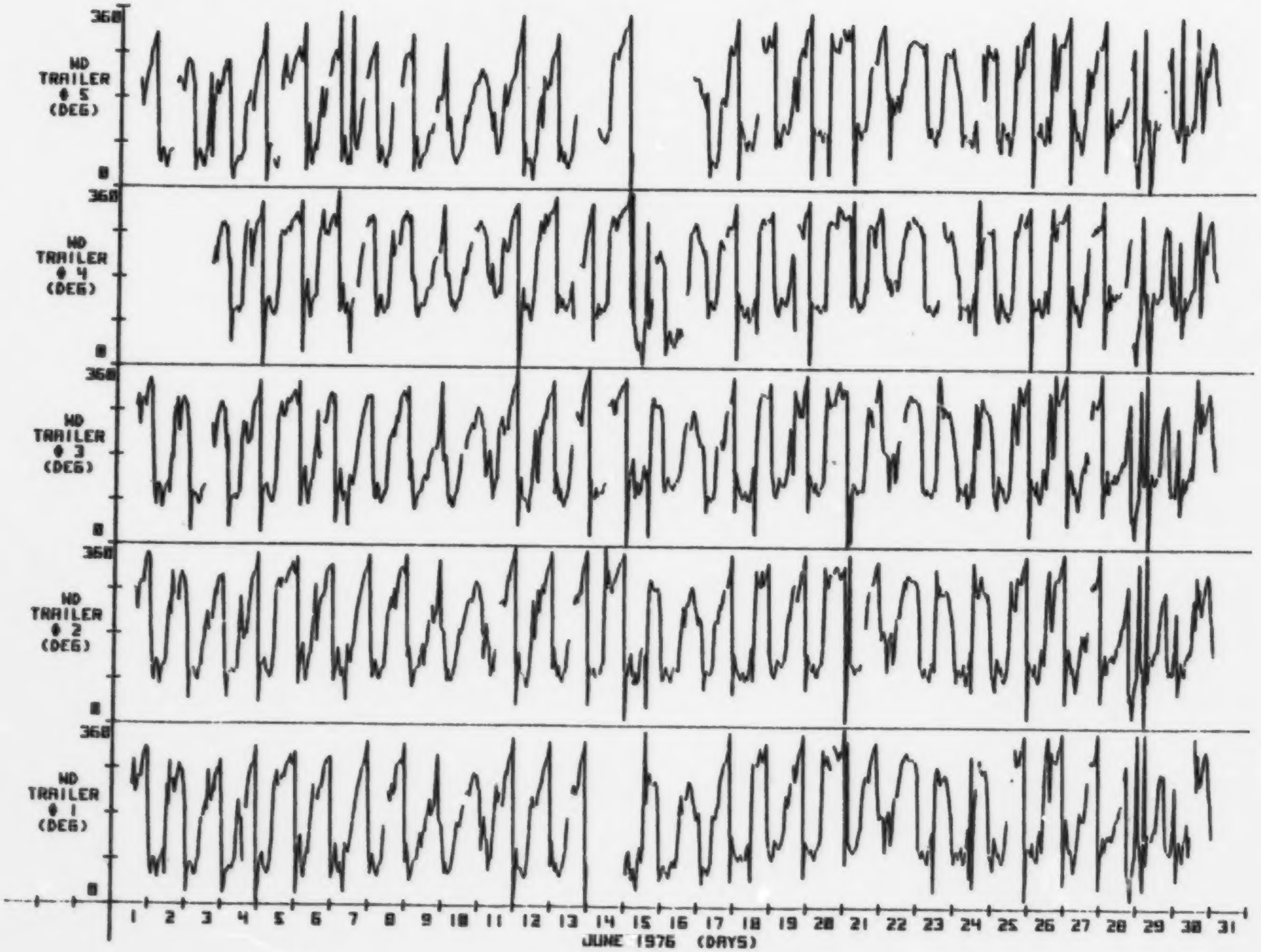
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JUNE 1976 (DAYS)

Figure H-6.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TRAILER
# 5
(DEG)
0
360
WD
TRAILER
# 4
(DEG)
0
360
WD
TRAILER
# 3
(DEG)
0
360
WD
TRAILER
# 2
(DEG)
0
360
WD
TRAILER
# 1
(DEG)
0
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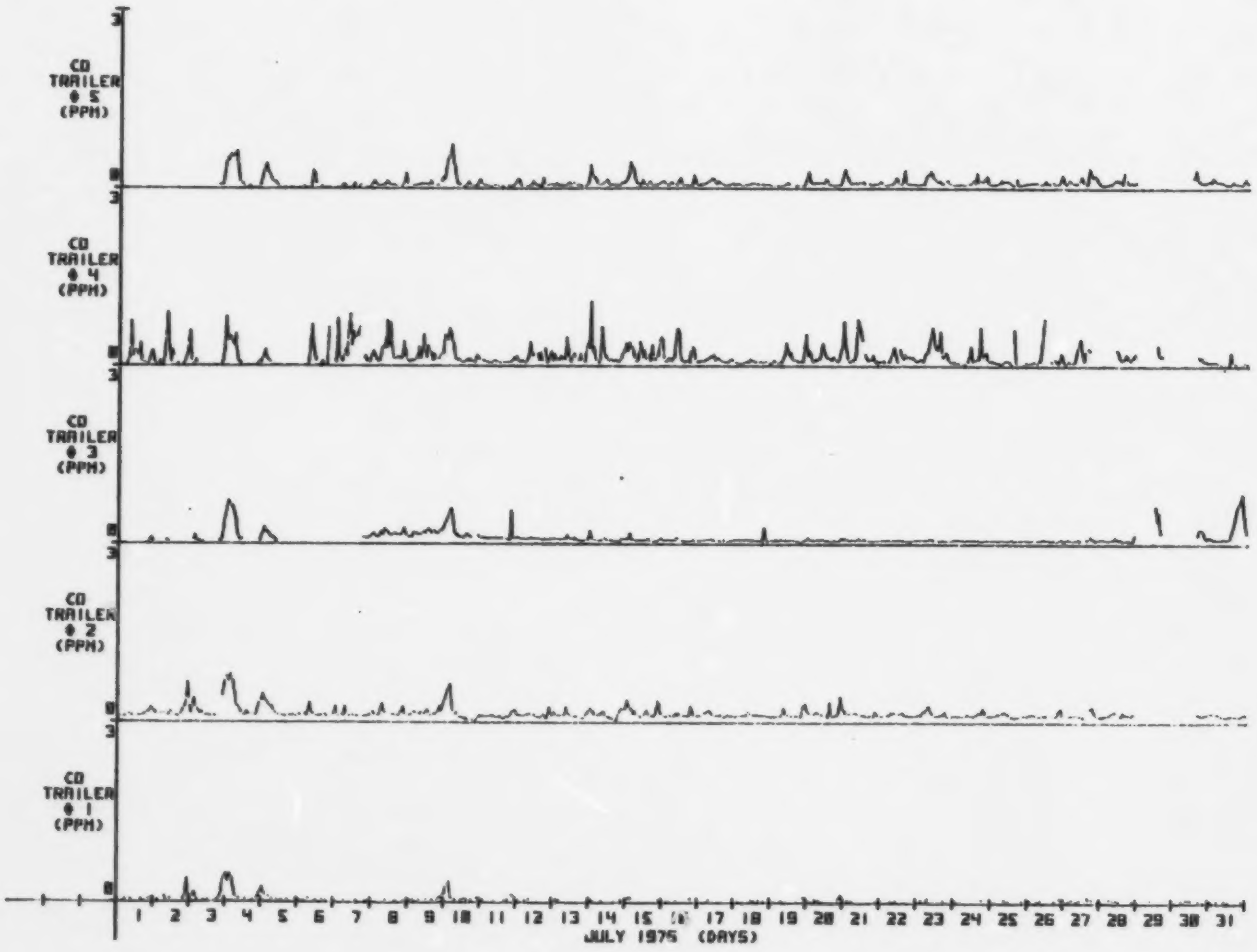
JUNE 1976 (DAYS)

Figure H-7.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CO TRAILER # 4 (PPM)
CO TRAILER # 3 (PPM)
CO TRAILER # 2 (PPM)
CO TRAILER # 1 (PPM)
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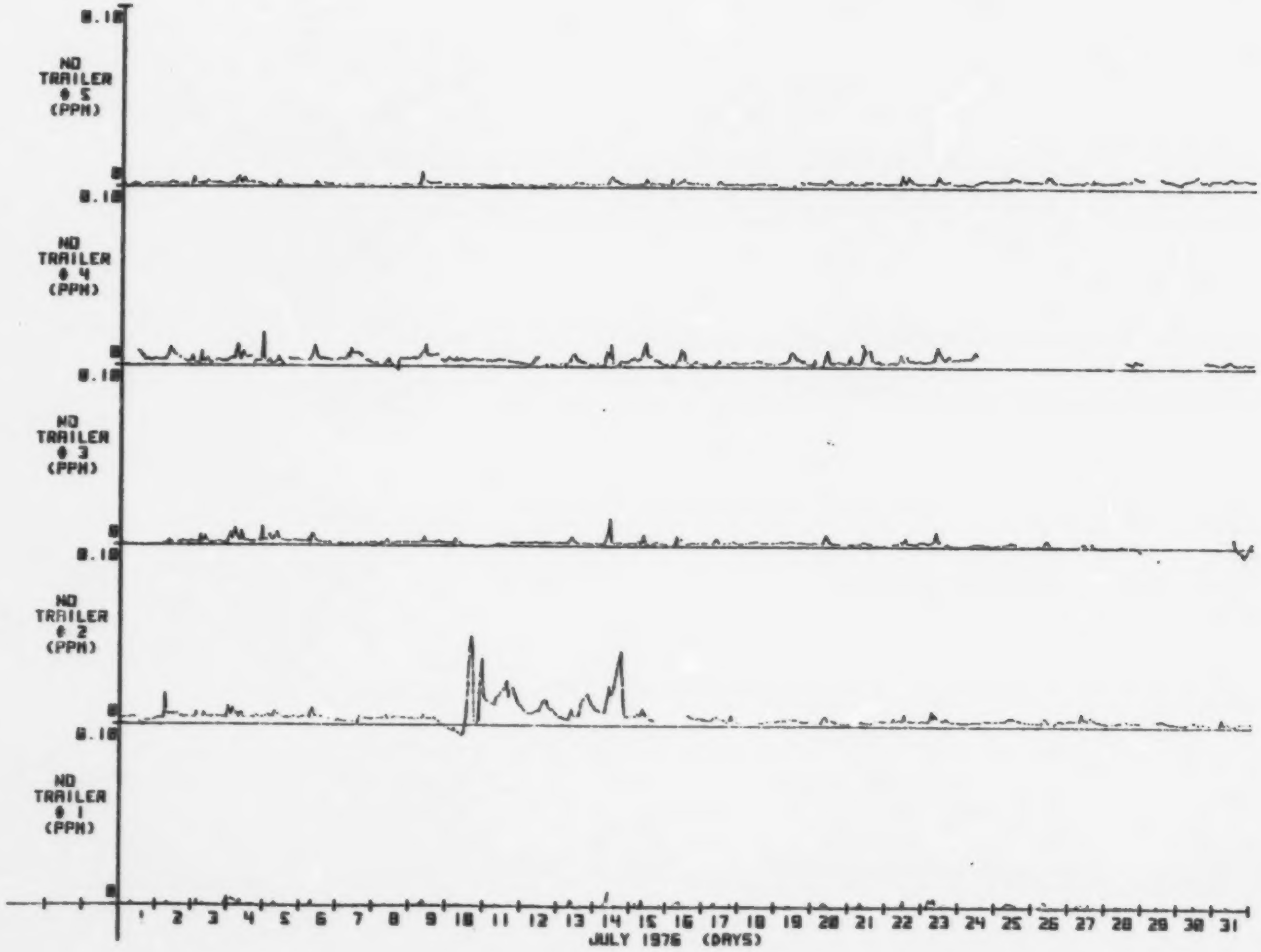
JULY 1975 (DAYS)

Figure H-8.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0.10
NO TRAILER # 4 (PPM)
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0.10
NO TRAILER # 3 (PPM)
0
0.10
NO TRAILER # 2 (PPM)
0
0.10
NO TRAILER # 1 (PPM)
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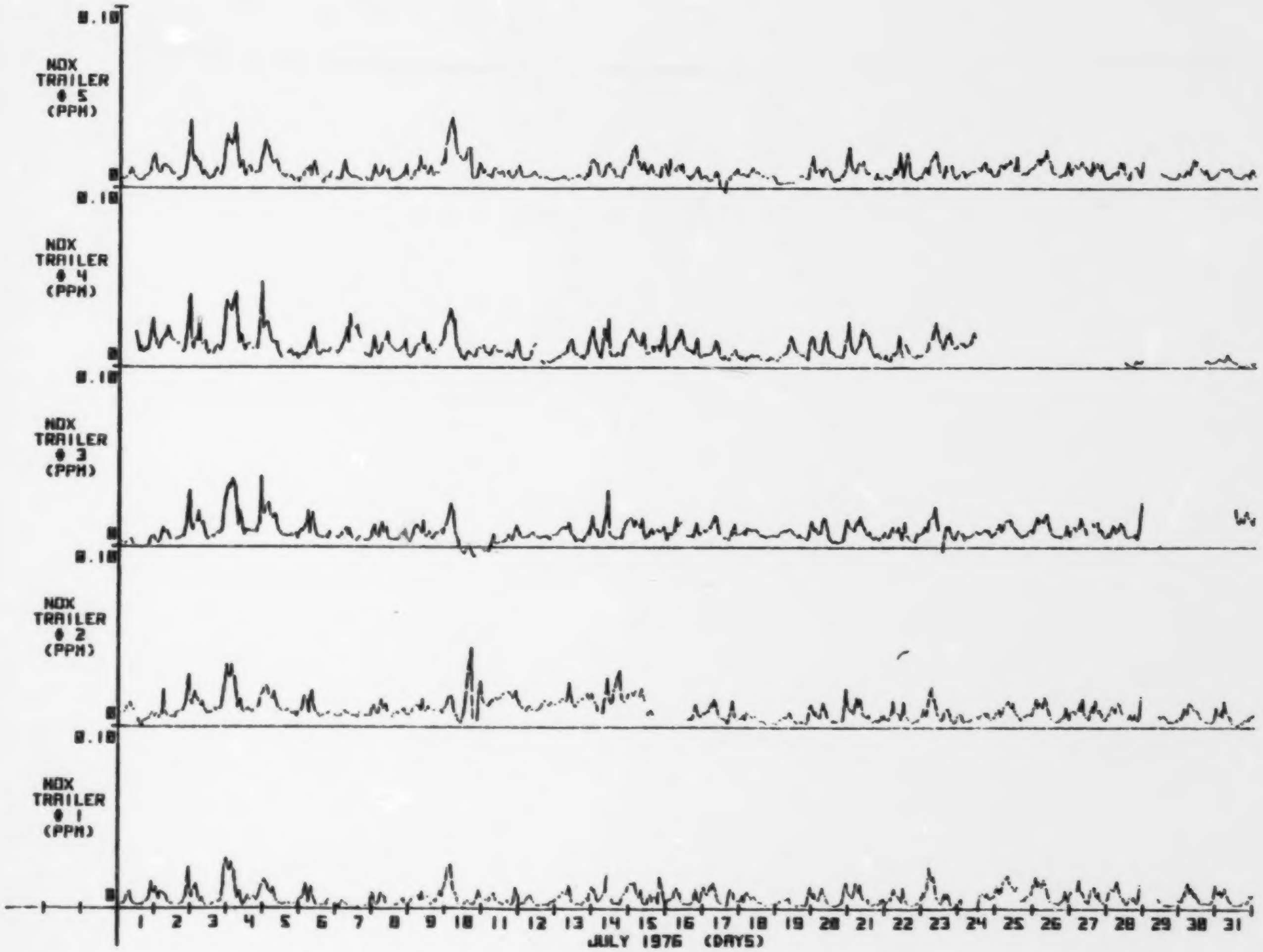
JULY 1976 (DAYS)

Figure H-9.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TRAILER
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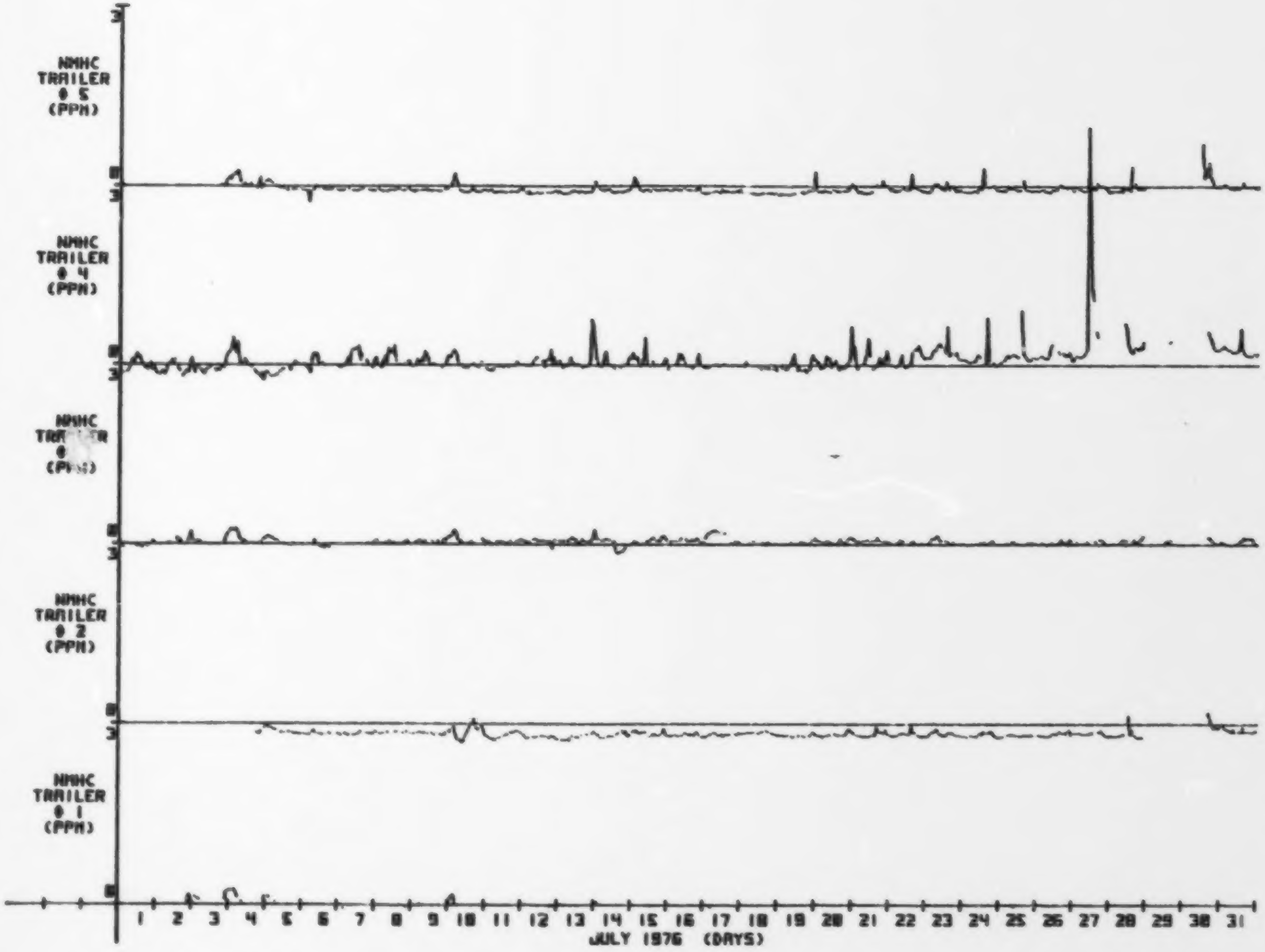
(PPM)
0
0.10
NOX
TRAILER
# 4
(PPM)
0
0.10
NOX
TRAILER
# 3
(PPM)
0
0.10
NOX
TRAILER
# 2
(PPM)
0
0.10
NOX
TRAILER
# 1
(PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JULY 1976 (DAYS)

Figure H-10.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3
NMHC TRAILER # 4 (PPM)
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3
NMHC TRAILER # (PPM)
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NMHC TRAILER # 2 (PPM)
0
3
NMHC TRAILER # 1 (PPM)
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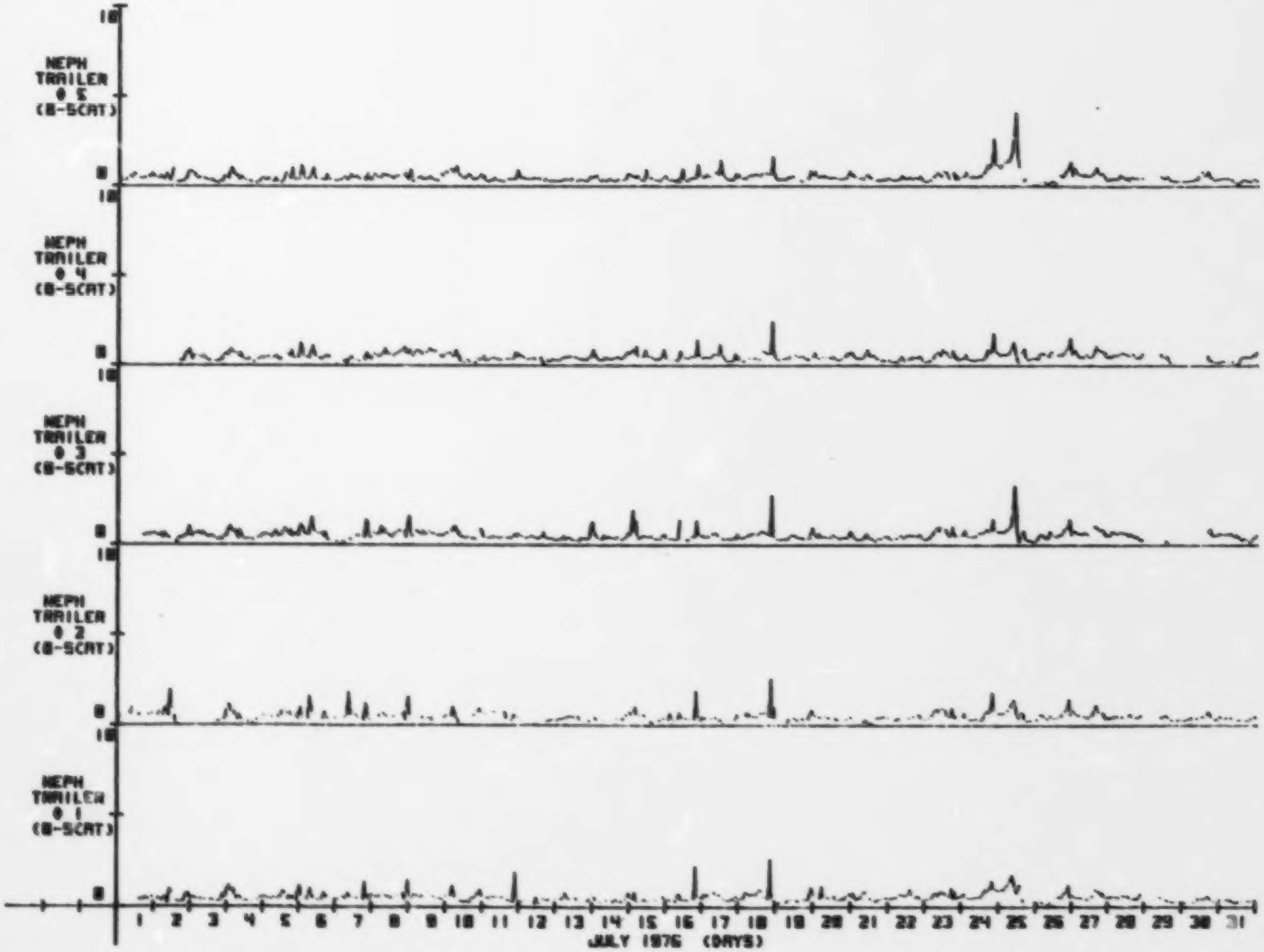
JULY 1976 (DAYS)

Figure H-11.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TRAILER
# 3
(B-SCAT)
0
10
NEPH
TRAILER
# 2
(B-SCAT)
0
10
NEPH
TRAILER
# 1
(B-SCAT)
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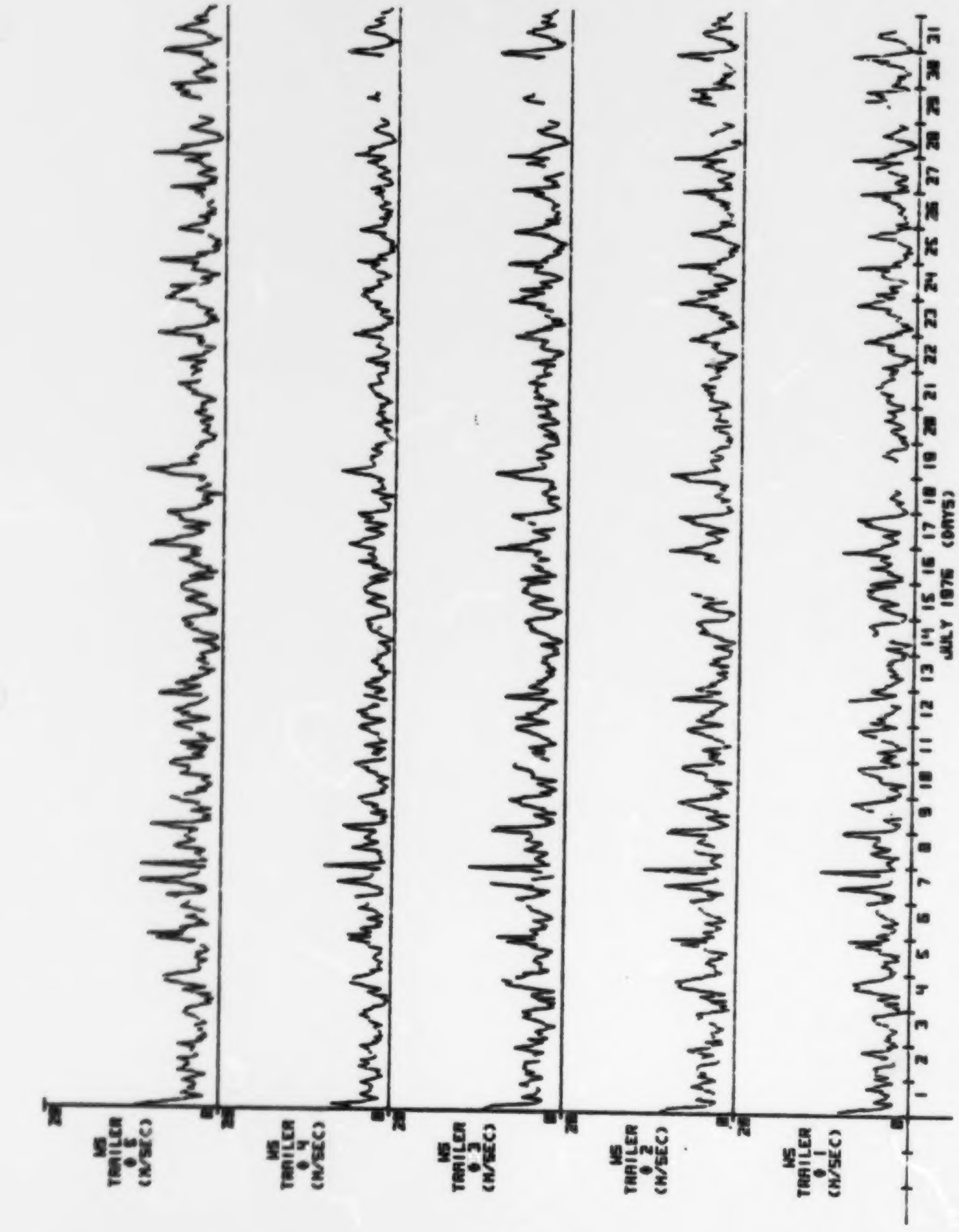
JULY 1976 (DAYS)

Figure H-12.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WS TRAILER # 3 (M/SEC)
WS TRAILER # 2 (M/SEC)
WS TRAILER # 1 (M/SEC)
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1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
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22
23
24
25
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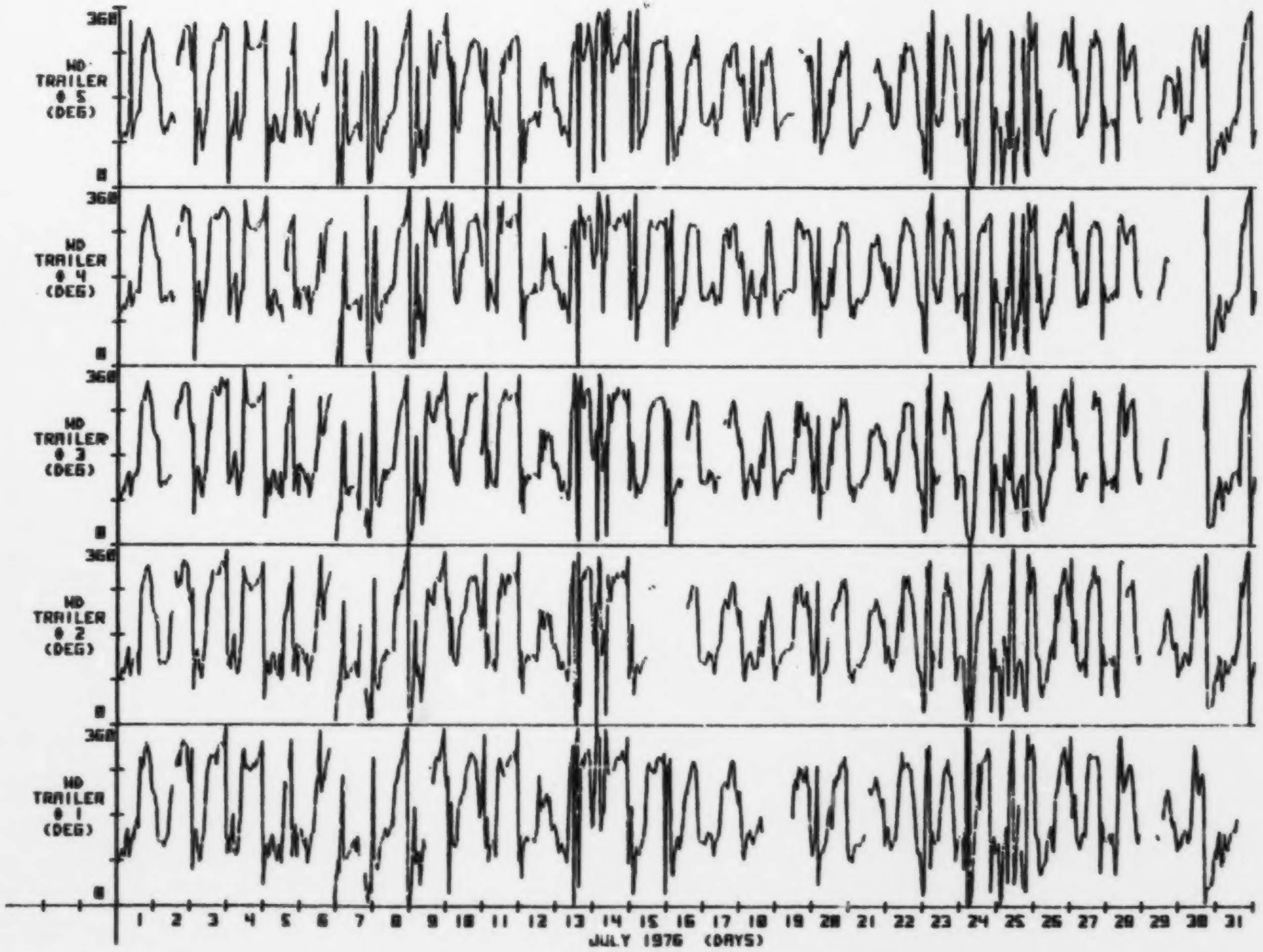
28
29
30
31
JULY 1976 (DAYS)

Figure H-13.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WD TRAILER # 4 (DEG)
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WD TRAILER # 3 (DEG)
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WD TRAILER # 2 (DEG)
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360
WD TRAILER # 1 (DEG)
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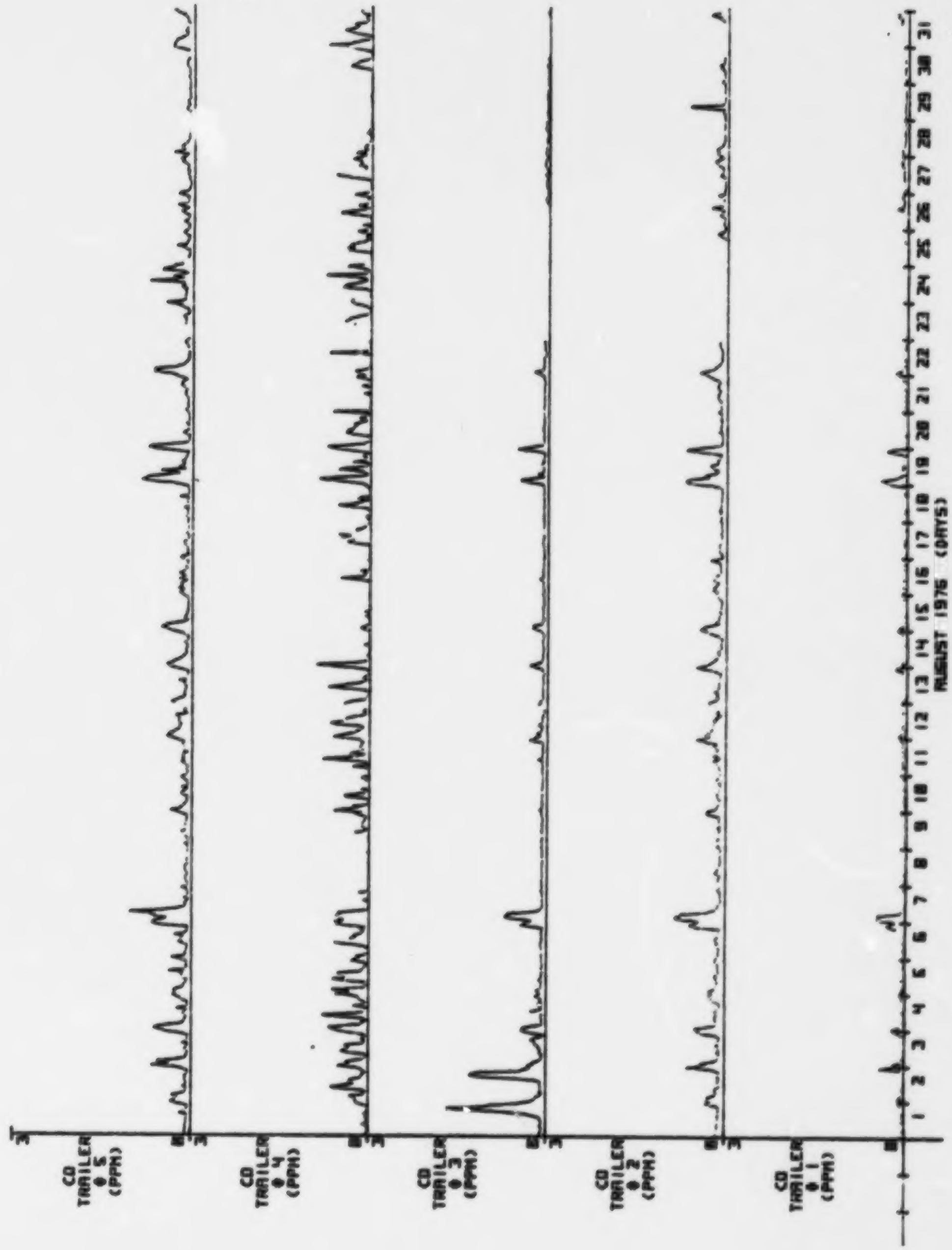
JULY 1976 (DAYS)

Figure H-14.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CO TRAILER # 1 (PPM)
3
0
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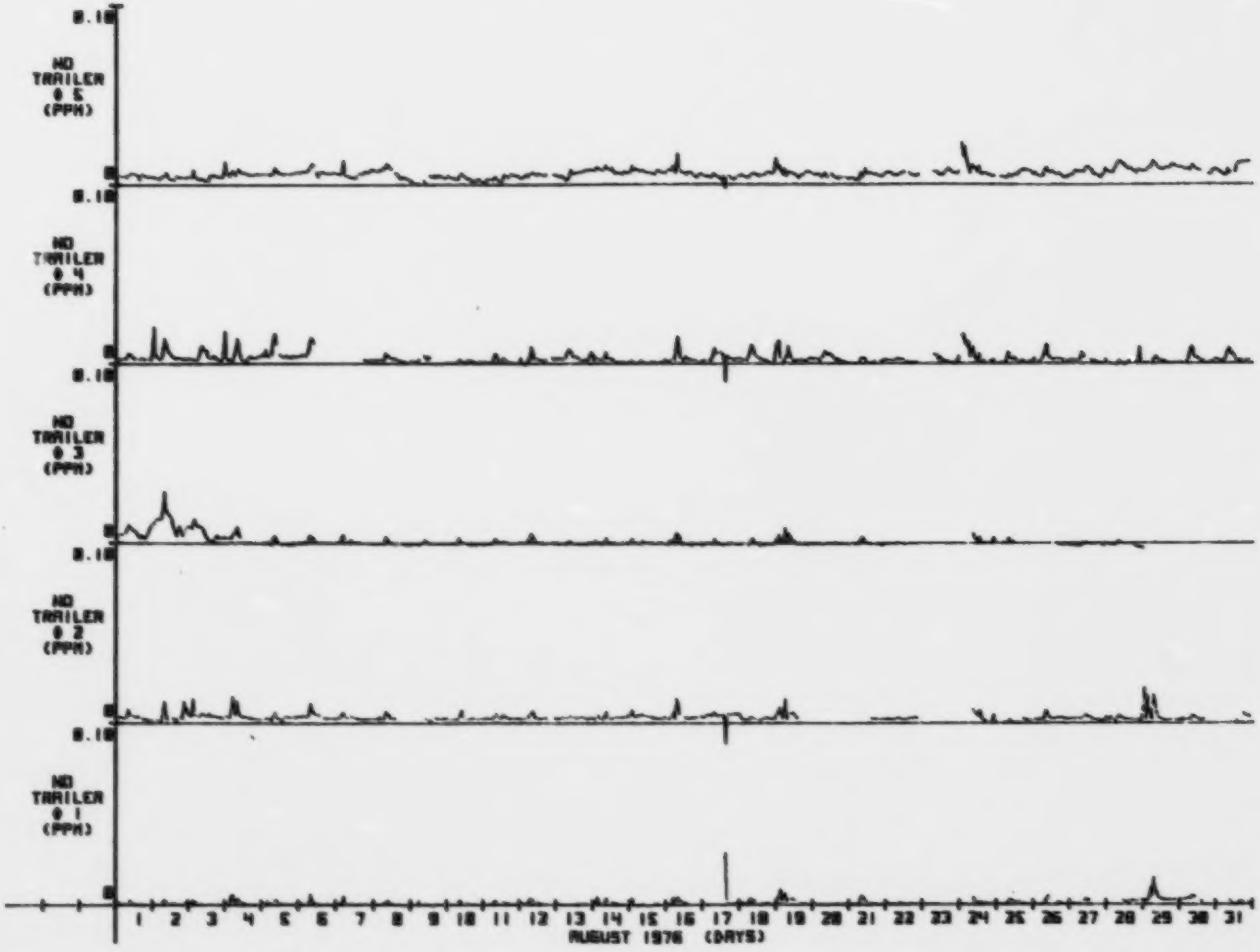
AUGUST 1976 (DAYS)

Figure H-15.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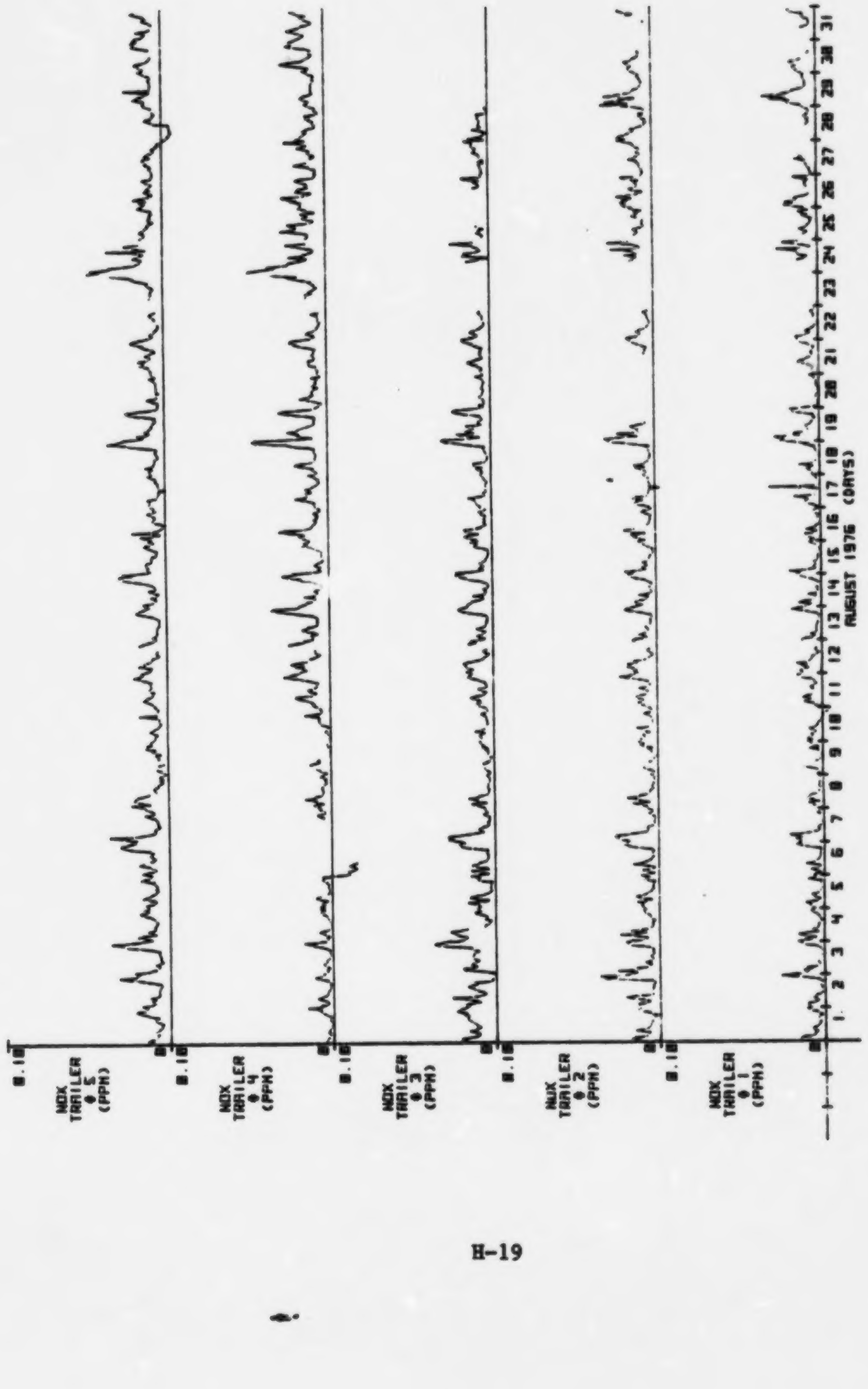
# 5
(PPM)
0
0.10
NO
TRAILER
# 4
(PPM)
0
0.10
NO
TRAILER
# 3
(PPM)
0
0.10
NO
TRAILER
# 2
(PPM)
0
0.10
NO
TRAILER
# 1
(PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
AUGUST 1976 (DAYS)

Figure H-16.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0.10
NOX TRAILER # 4 (PPM)
0
0.10
NOX TRAILER # 3 (PPM)
0
0.10
NUX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
AUGUST 1976 (DAYS)

Figure H-17.

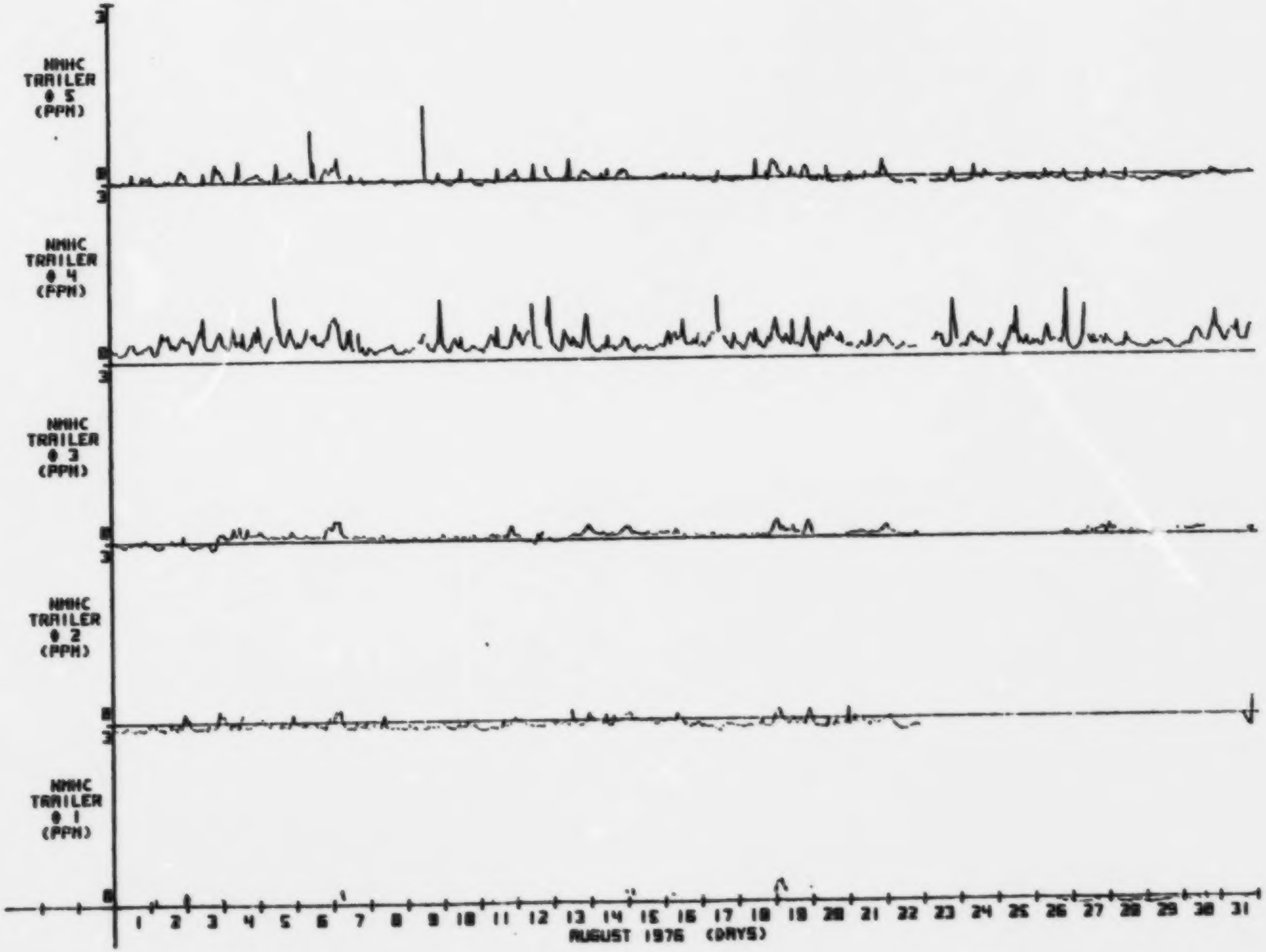

NMHC TRAILER # 5 (PPM)
NMHC TRAILER # 4 (PPM)
NMHC TRAILER # 3 (PPM)
NMHC TRAILER # 2 (PPM)
NMHC TRAILER # 1 (PPM)
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
AUGUST 1976 (DAYS)

Figure H-18.

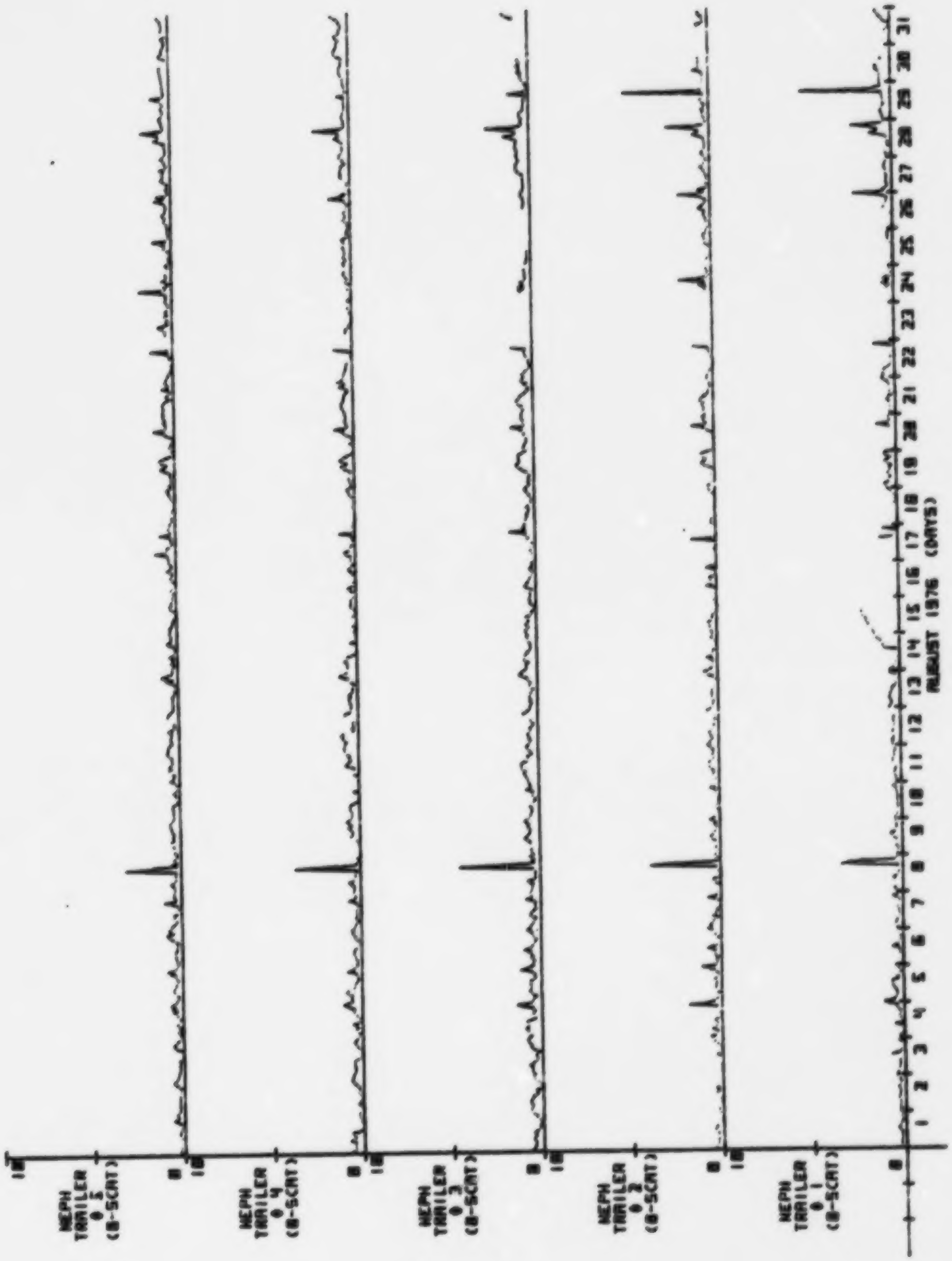

NEPH TRAILER 0.5 (B-SCAT)
NEPH TRAILER 0.4 (B-SCAT)
NEPH TRAILER 0.3 (B-SCAT)
NEPH TRAILER 0.2 (B-SCAT)
NEPH TRAILER 0.1 (B-SCAT)
0
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
AUGUST 1976 (DAYS)

Figure H-19.

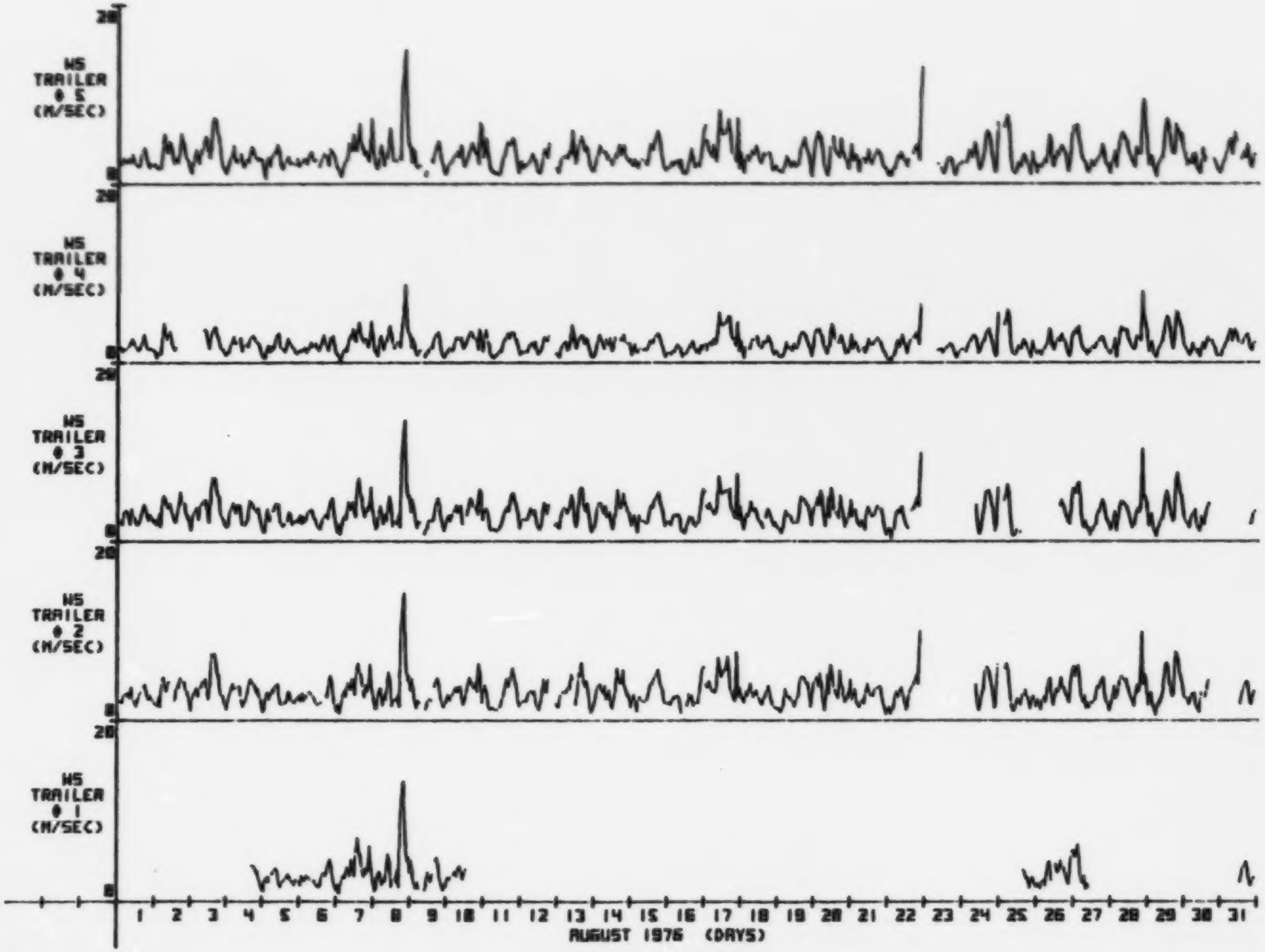

WS TRAILER # 5 (M/SEC)
WS TRAILER # 4 (M/SEC)
WS TRAILER # 3 (M/SEC)
WS TRAILER # 2 (M/SEC)
WS TRAILER # 1 (M/SEC)
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
AUGUST 1976 (DAYS)

Figure H-20.

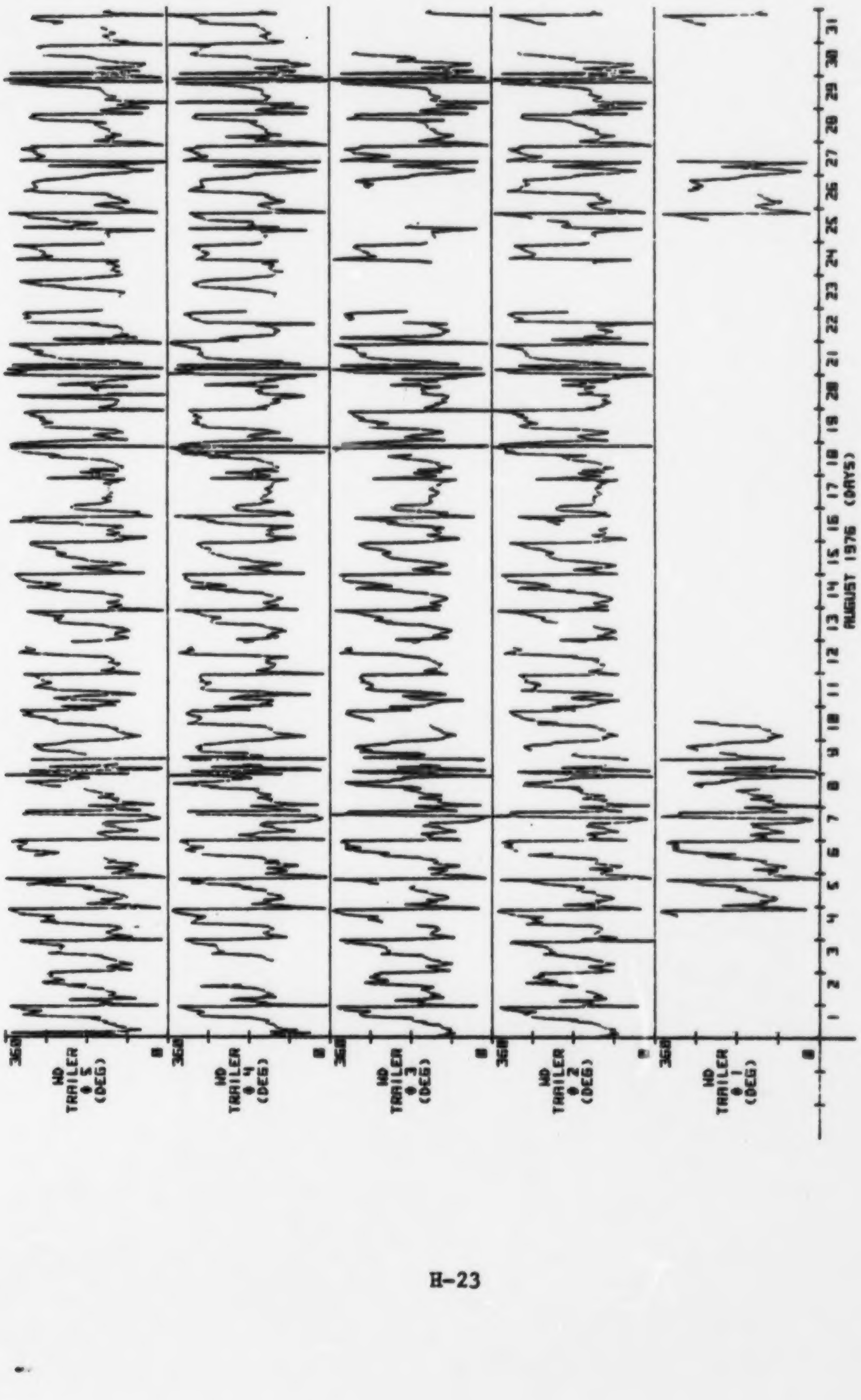

WD TRAILER # 5 (DEG)
WD TRAILER # 4 (DEG)
WD TRAILER # 3 (DEG)
WD TRAILER # 2 (DEG)
WD TRAILER # 1 (DEG)
360
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
AUGUST 1976 (DAYS)

Figure H-21.

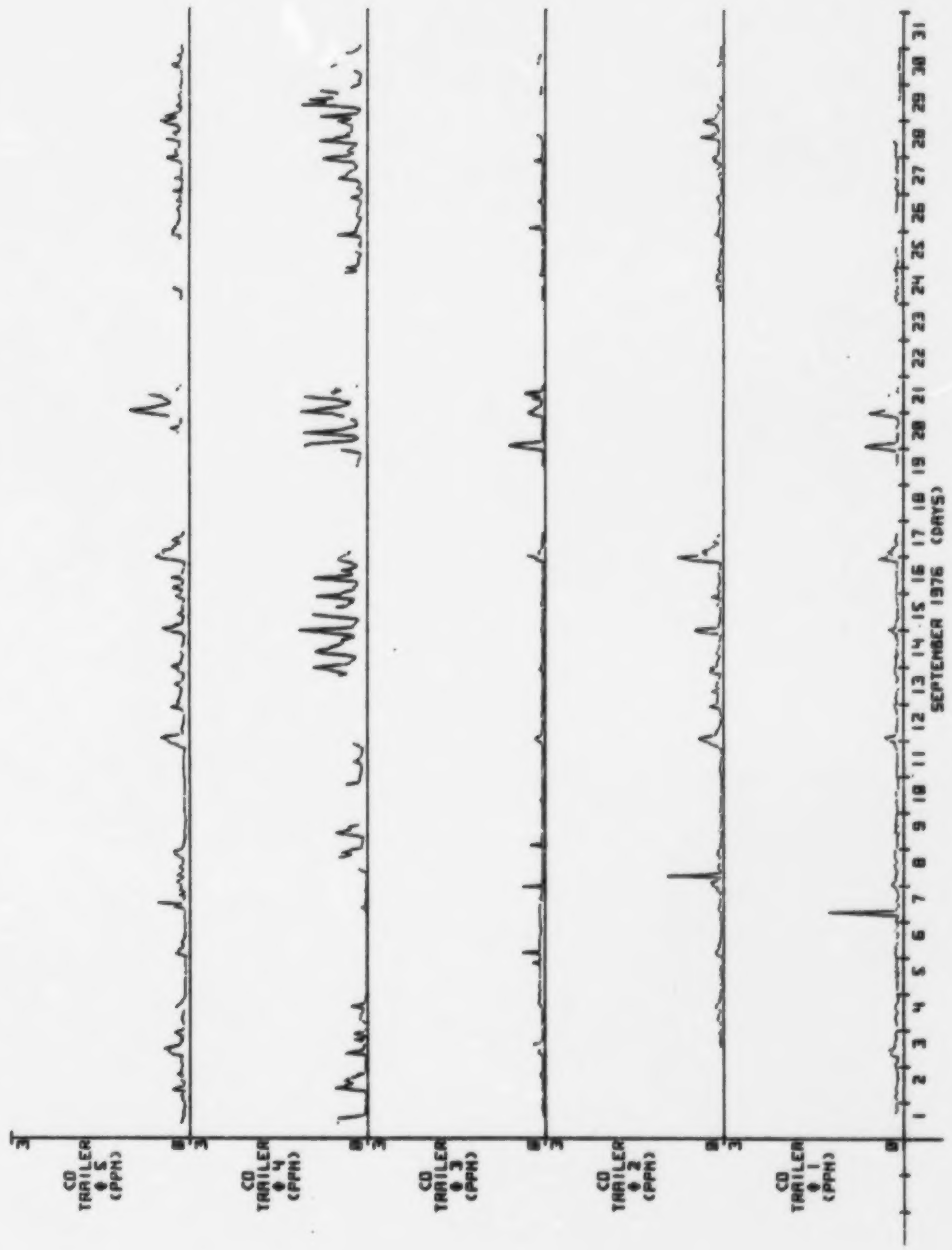
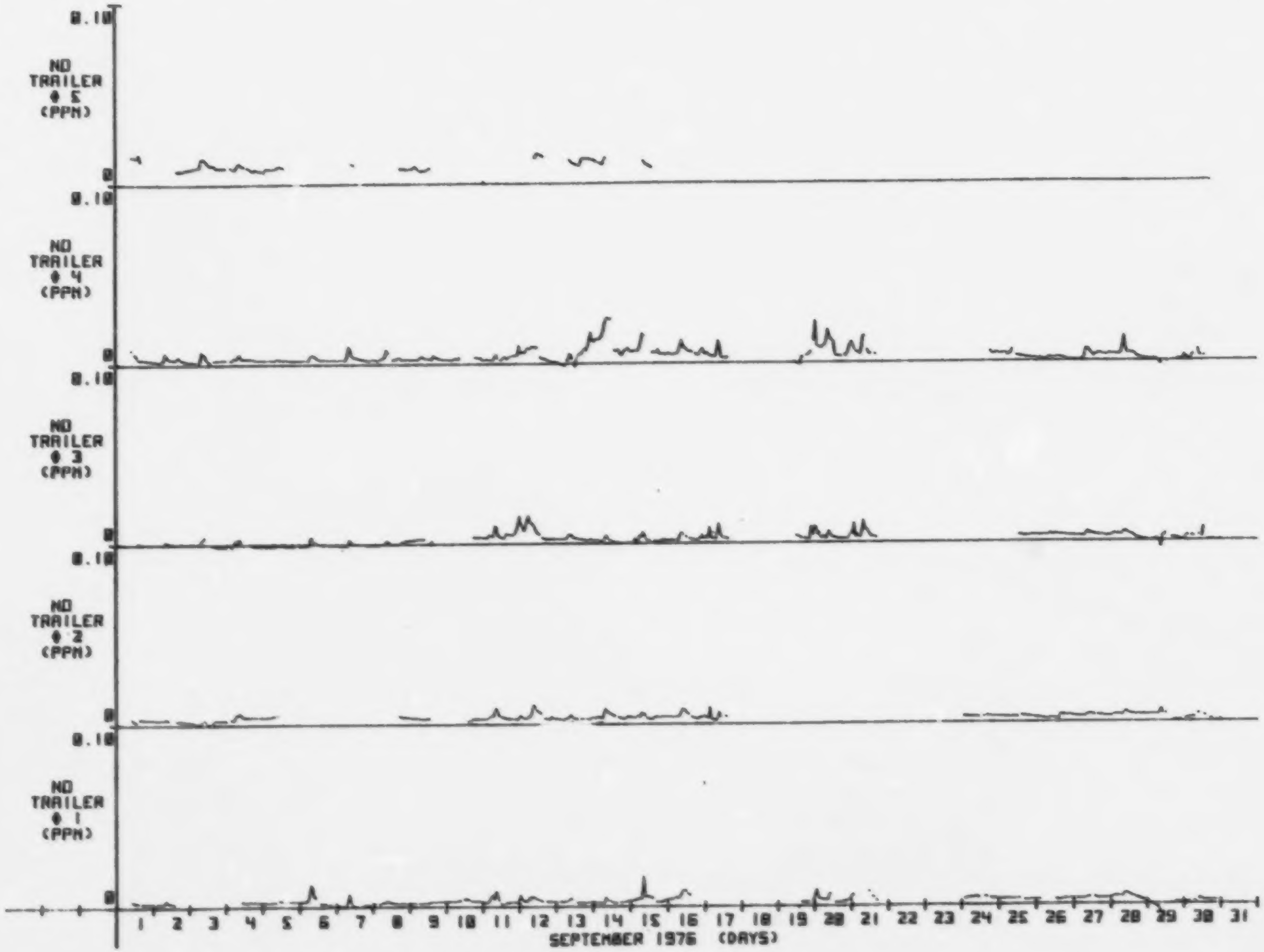

CO TRAILER # 5 (PPM)
3
0
CO TRAILER # 4 (PPM)
3
0
CO TRAILER # 3 (PPM)
3
0
CO TRAILER # 2 (PPM)
3
0
CO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEPTEMBER 1976 (DAYS)

Figure H-22.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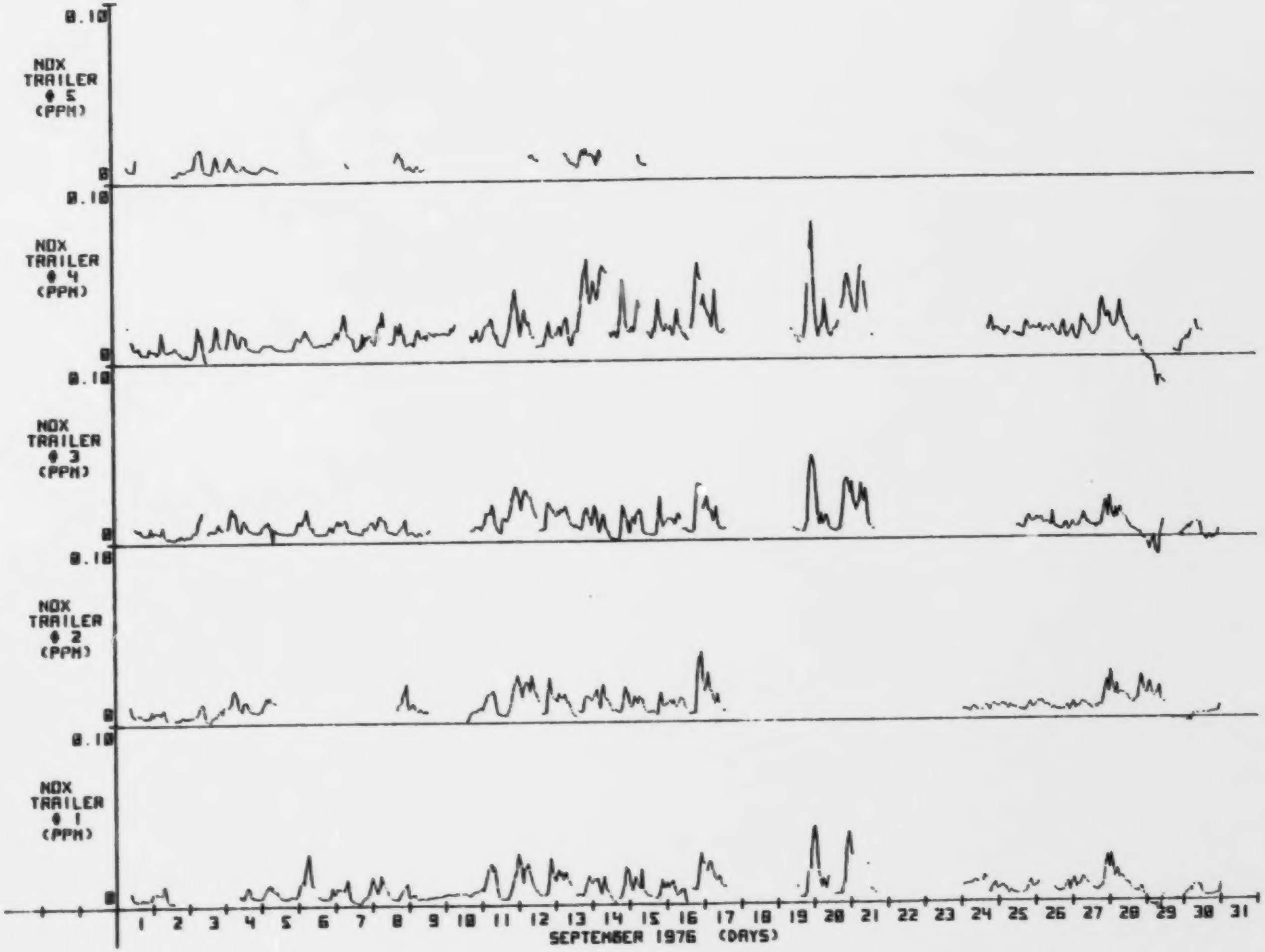
NO
TRAILER
# 5
(PPM)
0
0.10
NO
TRAILER
# 4
(PPM)
0
0.10
NO
TRAILER
# 3
(PPM)
0
0.10
NO
TRAILER
# 2
(PPM)
0
0.10
NO
TRAILER
# 1
(PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEPTEMBER 1976 (DAYS)

Figure H-23.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NOX TRAILER # 5 (PPM)
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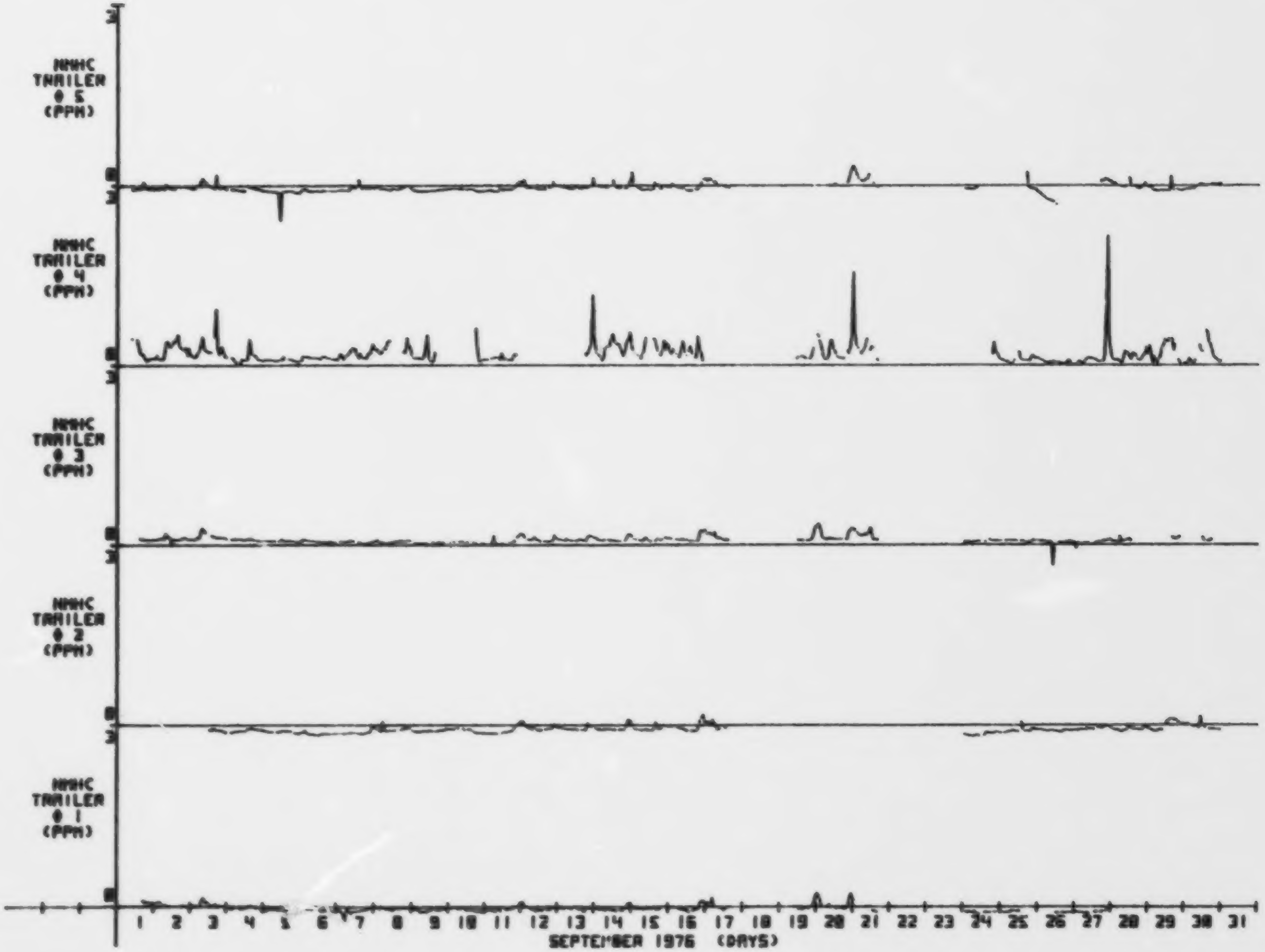
0.10
NOX TRAILER # 4 (PPM)
0
0.10
NOX TRAILER # 3 (PPM)
0
0.10
NOX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEPTEMBER 1976 (DAYS)

Figure H-24.

NMHC TRAILER # 5 (PPM)
NMHC TRAILER # 4 (PPM)
NMHC TRAILER # 3 (PPM)
NMHC TRAILER # 2 (PPM)
NMHC TRAILER # 1 (PPM)
3
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEPTEMBER 1976 (DAYS)

Figure H-25.

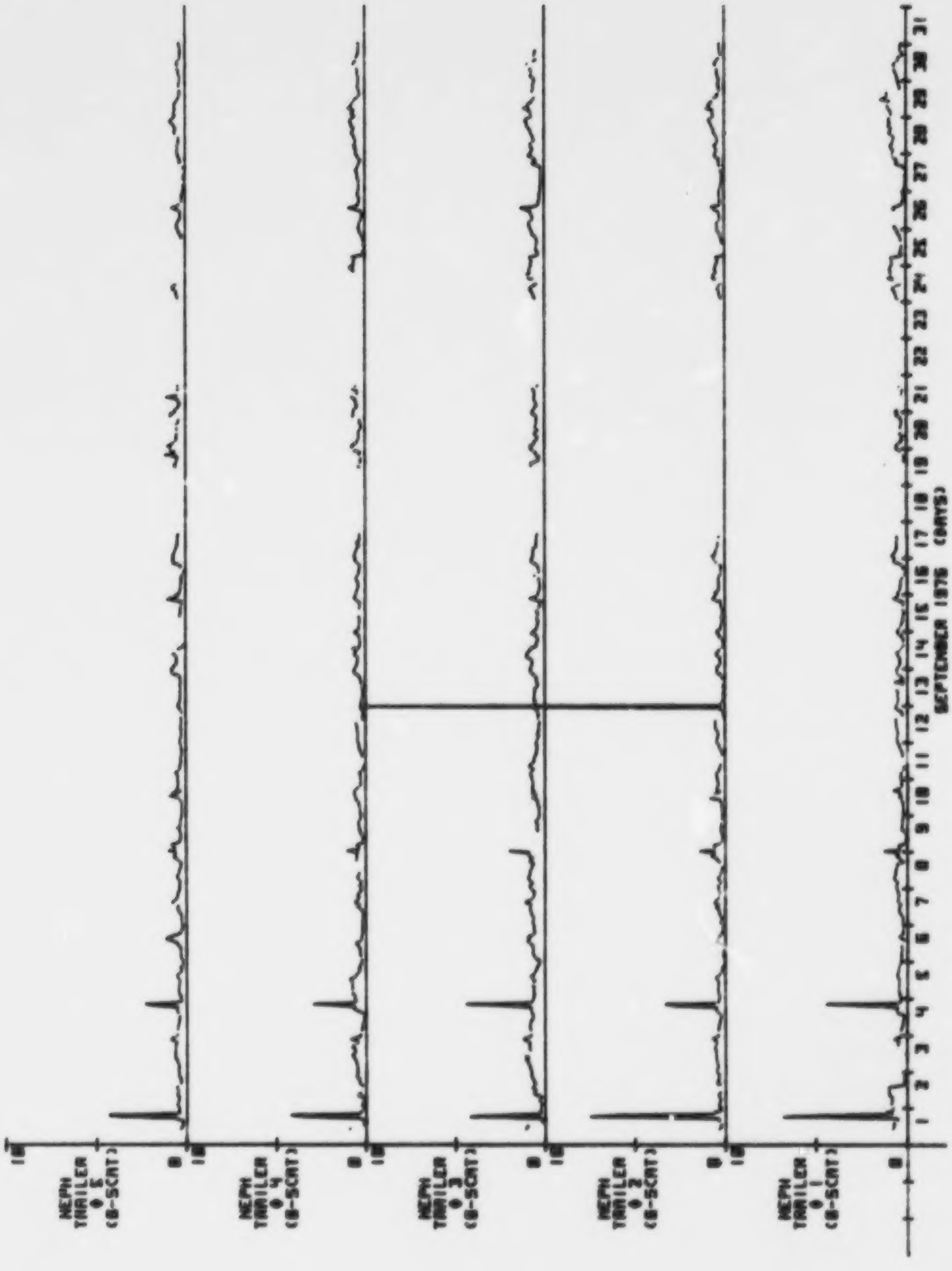

NEPH TRAILER # 5 (B-SCAT)
NEPH TRAILER # 4 (B-SCAT)
NEPH TRAILER # 3 (B-SCAT)
NEPH TRAILER # 2 (B-SCAT)
NEPH TRAILER # 1 (B-SCAT)
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEPTEMBER 1976 (DAYS)

Figure H-26.

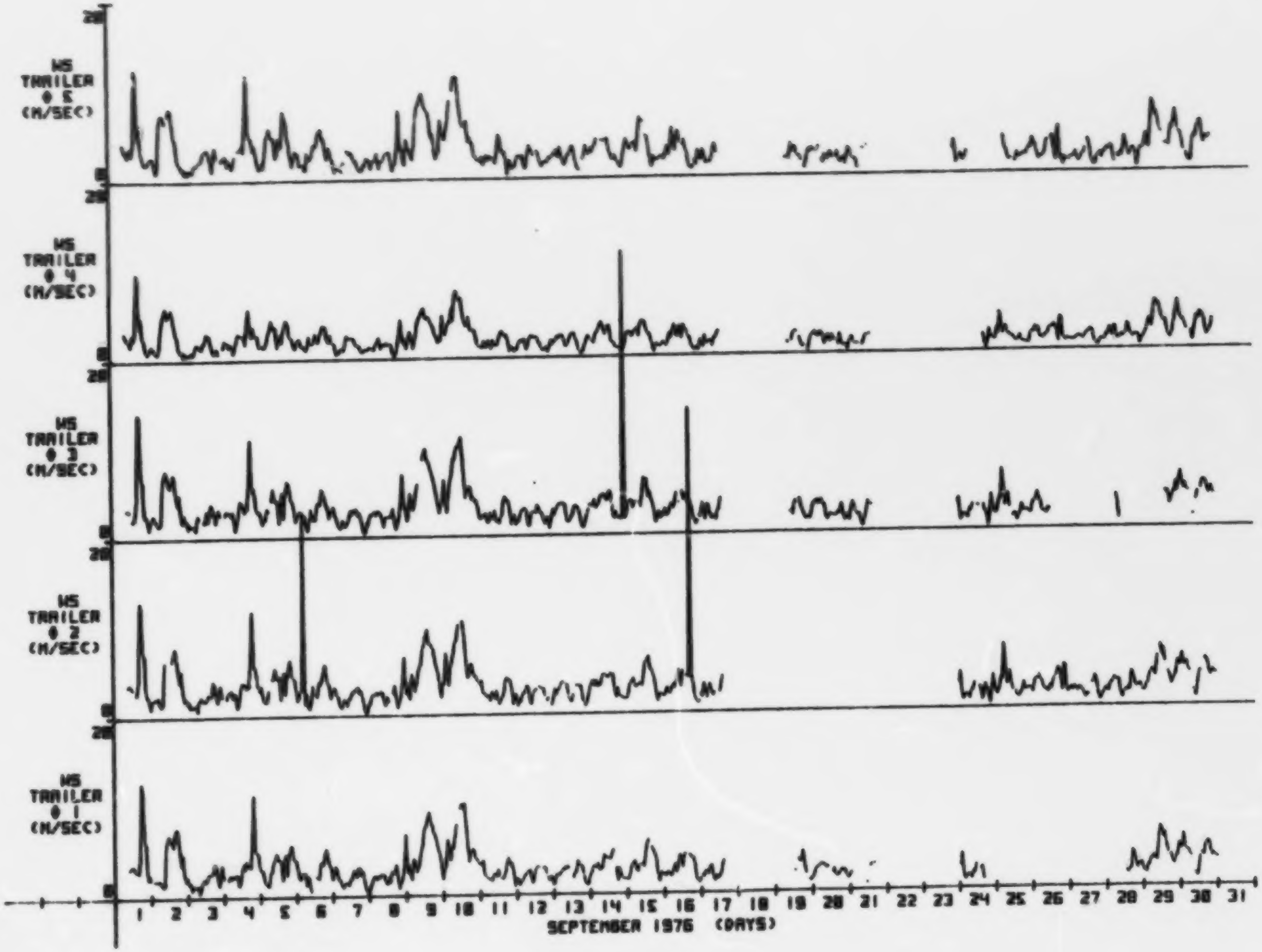

20
WS
TRAILER
# 5
(M/SEC)
0
20
WS
TRAILER
# 4
(M/SEC)
0
20
WS
TRAILER
# 3
(M/SEC)
0
20
WS
TRAILER
# 2
(M/SEC)
0
20
WS
TRAILER
# 1
(M/SEC)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEPTEMBER 1976 (DAYS)

Figure H-27.

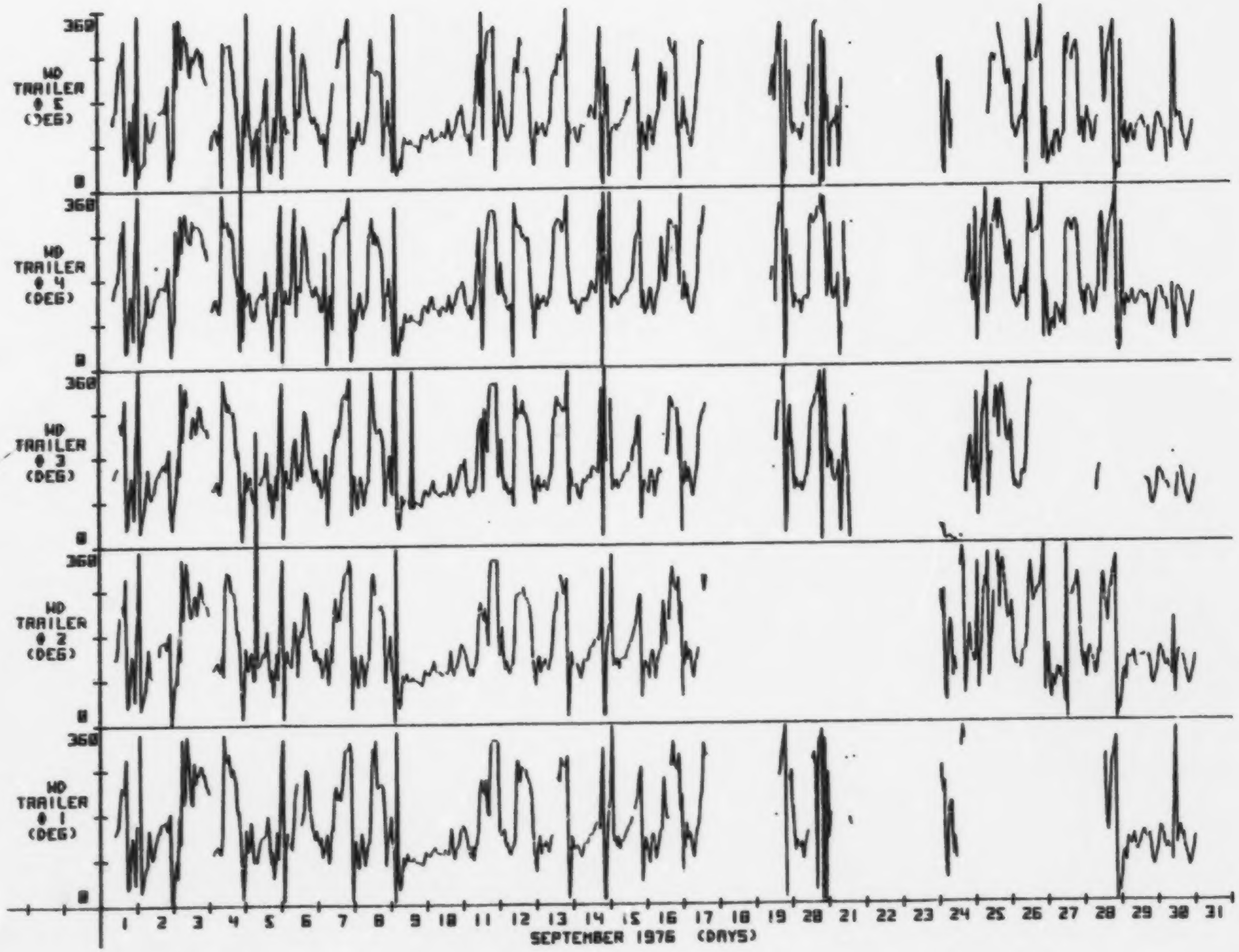

360
WD TRAILER # 5 (DEG)
0
360
WD TRAILER # 4 (DEG)
0
360
WD TRAILER # 3 (DEG)
0
360
WD TRAILER # 2 (DEG)
0
360
WD TRAILER # 1 (DEG)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEPTEMBER 1976 (DAYS)

Figure H-28.

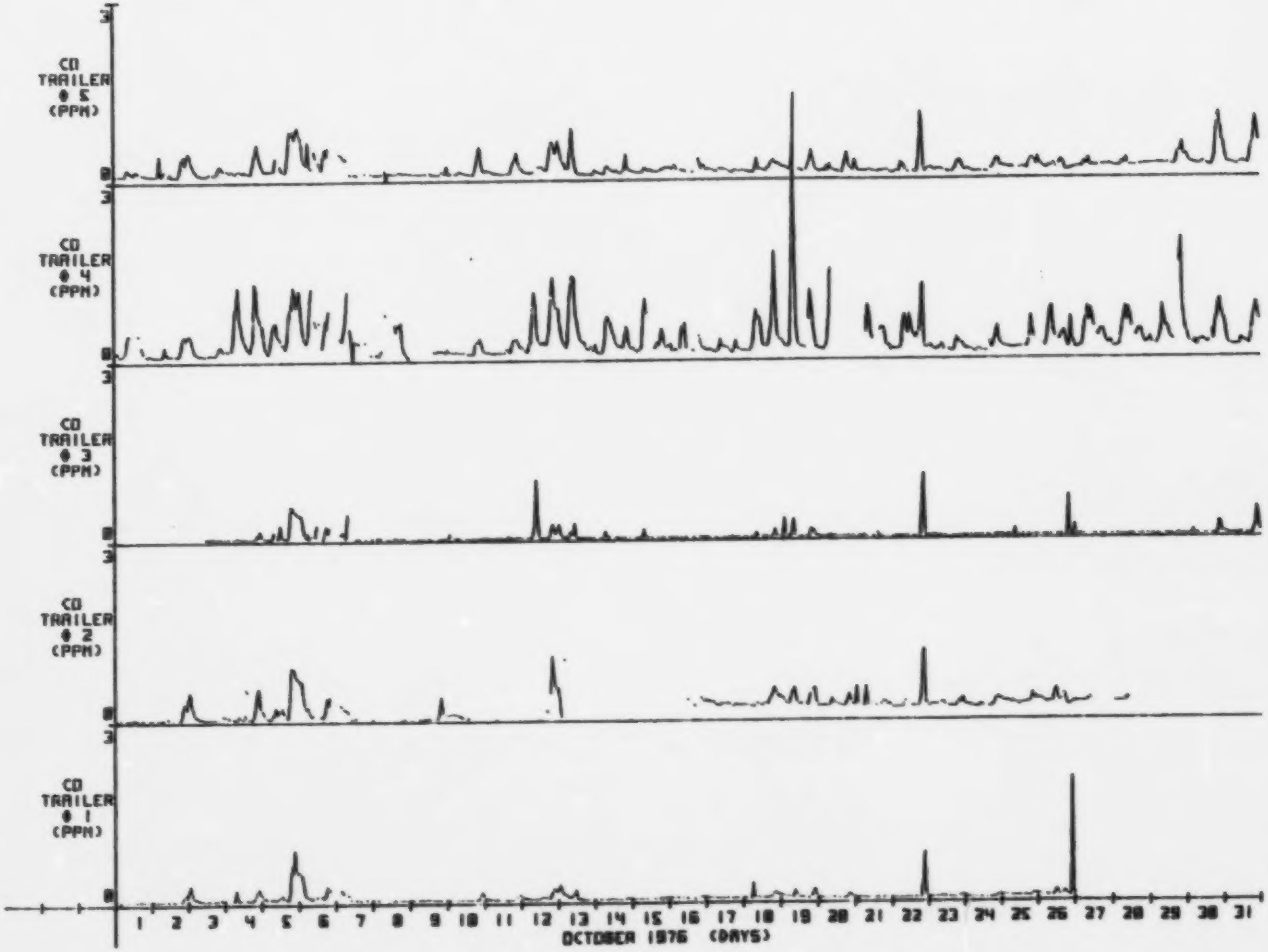

3
CO TRAILER # 5 (PPM)
0
3
CO TRAILER # 4 (PPM)
0
3
CO TRAILER # 3 (PPM)
0
3
CO TRAILER # 2 (PPM)
0
3
CO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
OCTOBER 1976 (DAYS)

Figure H-29.

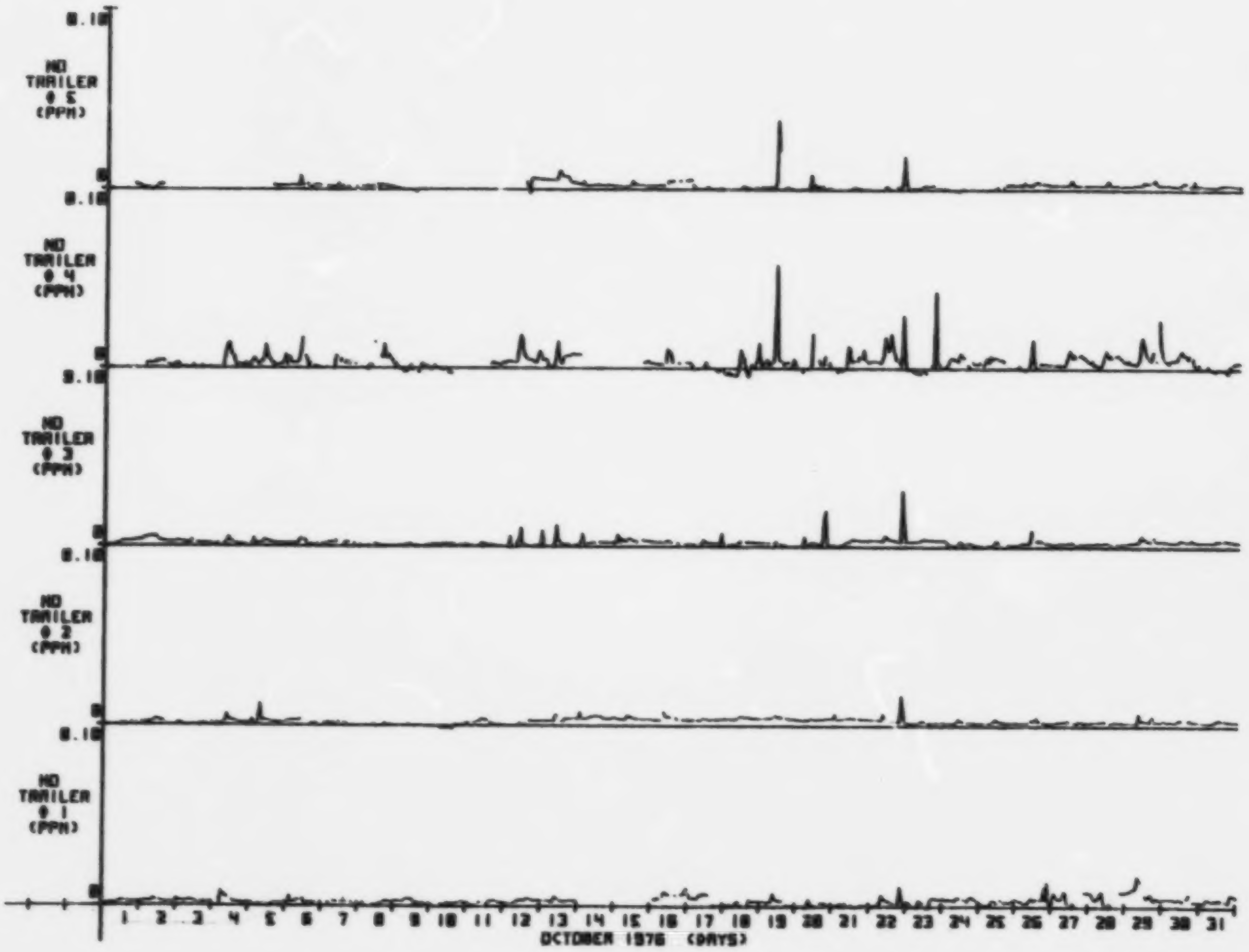
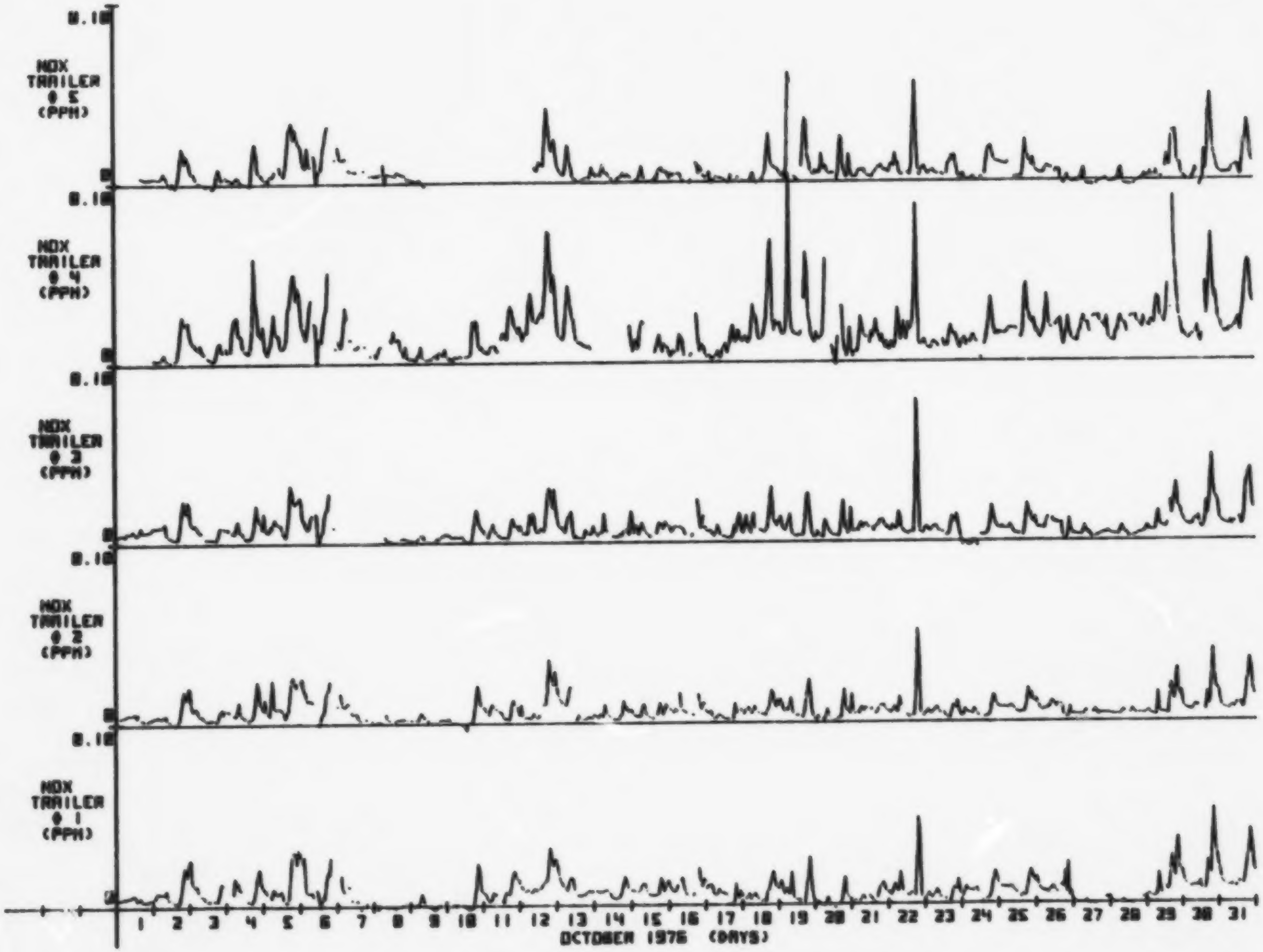

0.10
NO
TRAILER
# 5
(PPM)
0
0.10
NO
TRAILER
# 4
(PPM)
0
0.10
NO
TRAILER
# 3
(PPM)
0
0.10
NO
TRAILER
# 2
(PPM)
0
0.10
NO
TRAILER
# 1
(PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
OCTOBER 1976 (DAYS)

Figure H-30.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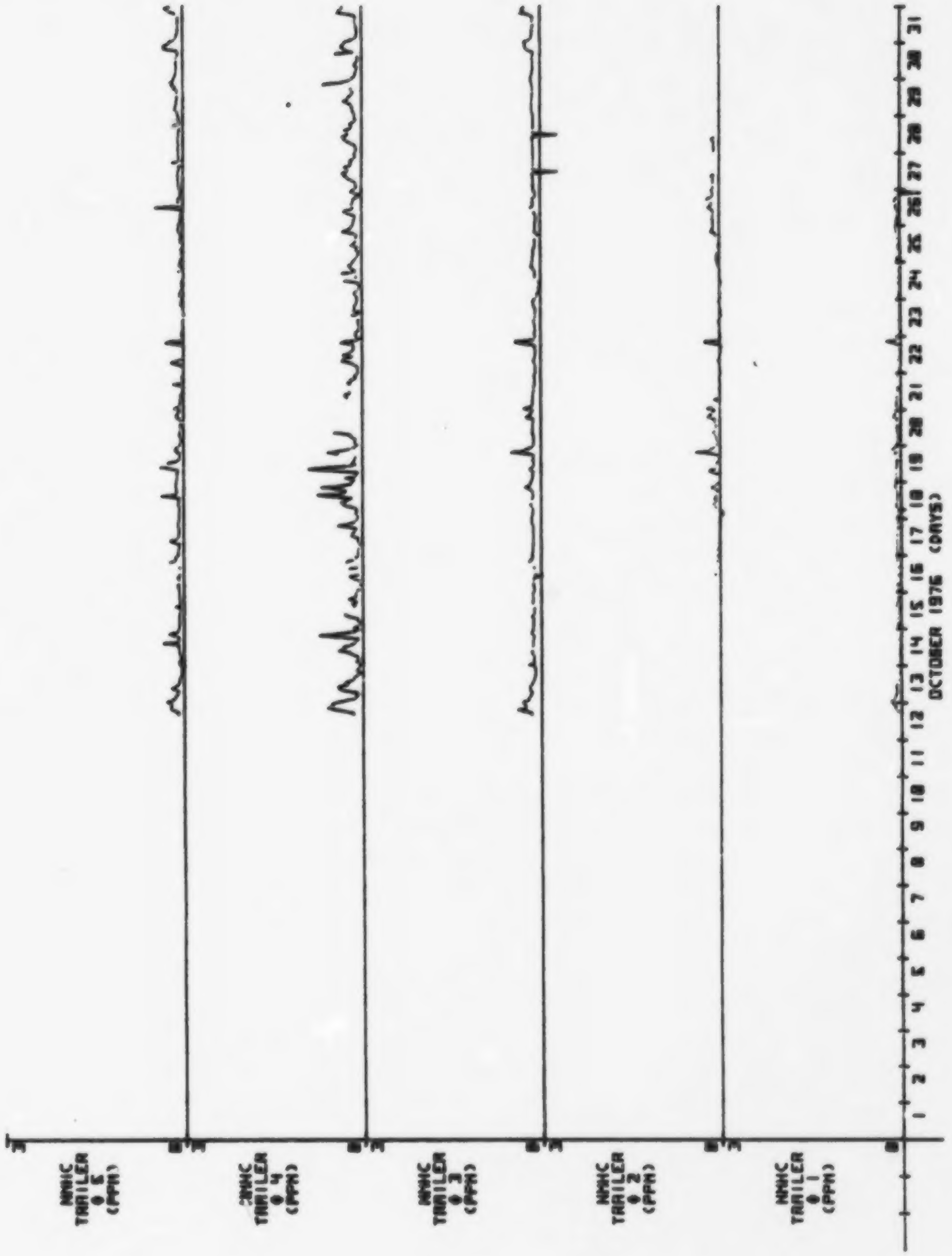
0.10
NOX TRAILER # 4 (PPM)
0
0.10
NOX TRAILER # 3 (PPM)
0
0.10
NOX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
OCTOBER 1976 (DAYS)

Figure H-31.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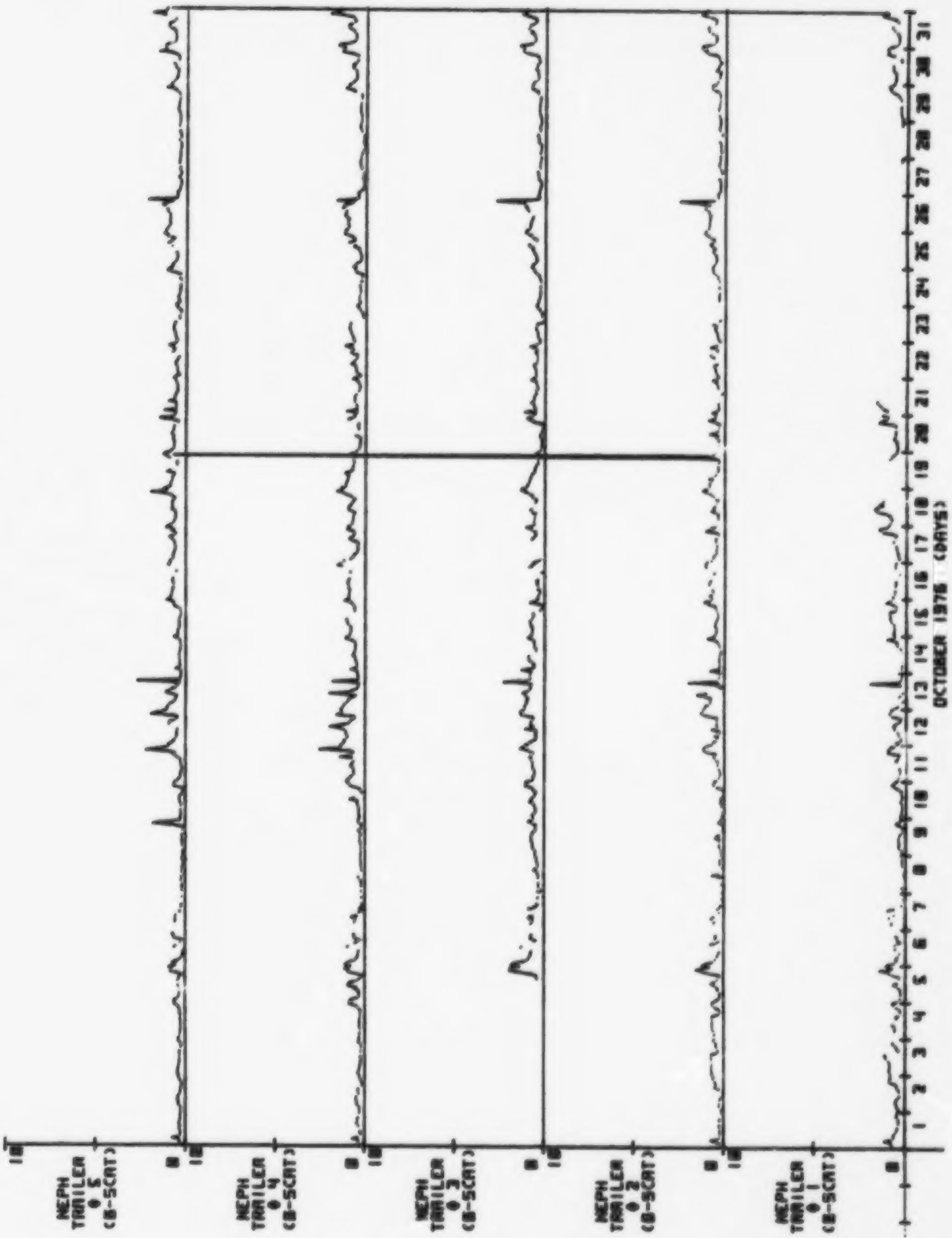
NMHC TRAILER # 4 (PPM)
NMHC TRAILER # 3 (PPM)
NMHC TRAILER # 2 (PPM)
NMHC TRAILER # 1 (PPM)
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
OCTOBER 1976 (DAYS)

Figure H-32.


NEPH TRAILER # 5 (B-SCAT)
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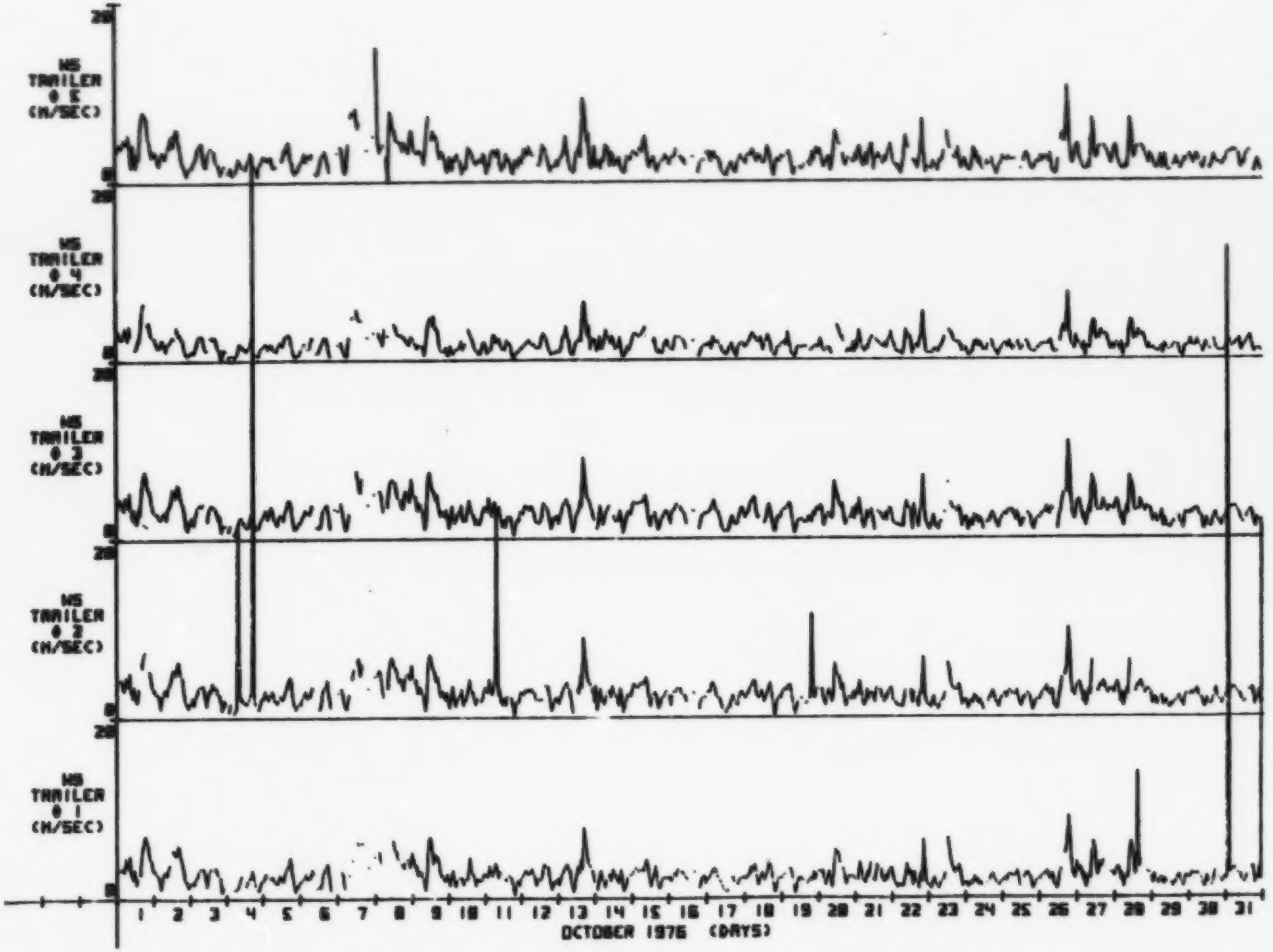
0
NEPH TRAILER # 4 (B-SCAT)
10
0
NEPH TRAILER # 3 (B-SCAT)
10
0
NEPH TRAILER # 2 (B-SCAT)
10
0
NEPH TRAILER # 1 (B-SCAT)
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
OCTOBER 1978 (DAYS)

Figure H-33.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WS TRAILER # 5 (M/SEC)
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20
WS TRAILER # 4 (M/SEC)
0
20
WS TRAILER # 3 (M/SEC)
0
20
WS TRAILER # 2 (M/SEC)
0
20
WS TRAILER # 1 (M/SEC)
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
OCTOBER 1976 (DAYS)

Figure H-34.

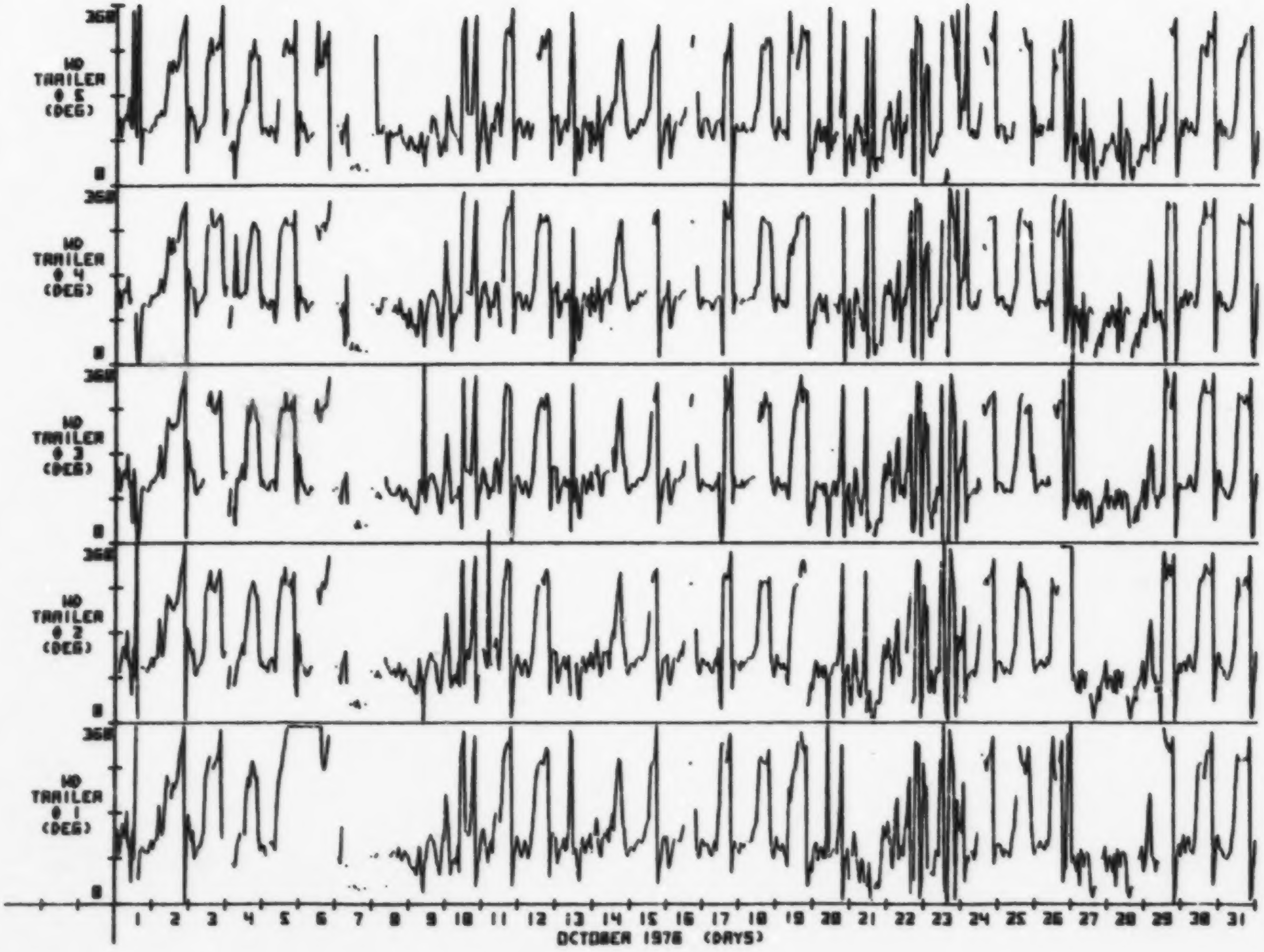

360
WD TRAILER @ 5 (DEG)
0
360
WD TRAILER @ 4 (DEG)
0
360
WD TRAILER @ 3 (DEG)
0
360
WD TRAILER @ 2 (DEG)
0
360
WD TRAILER @ 1 (DEG)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
OCTOBER 1976 (DAYS)

Figure H-35.

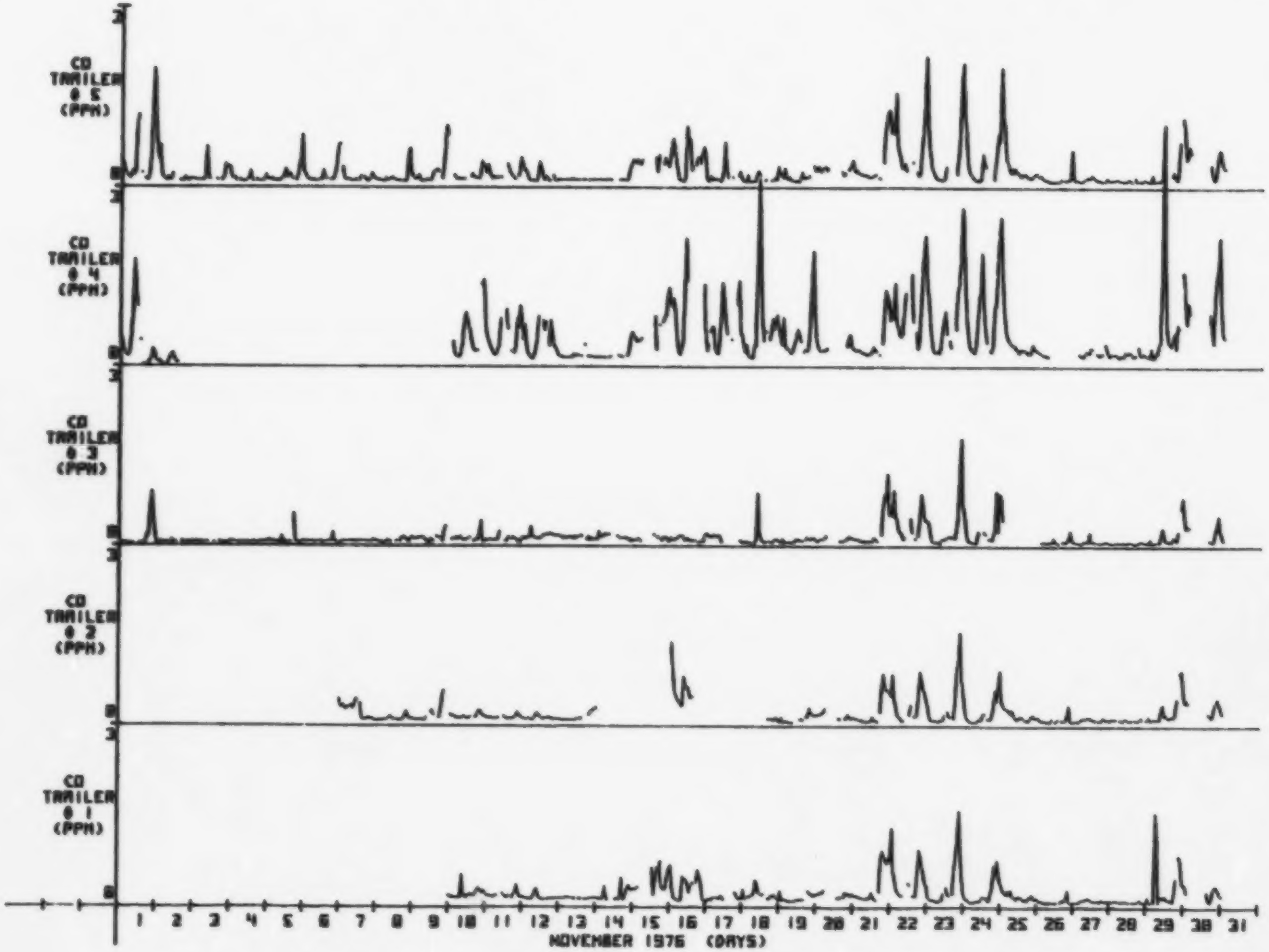
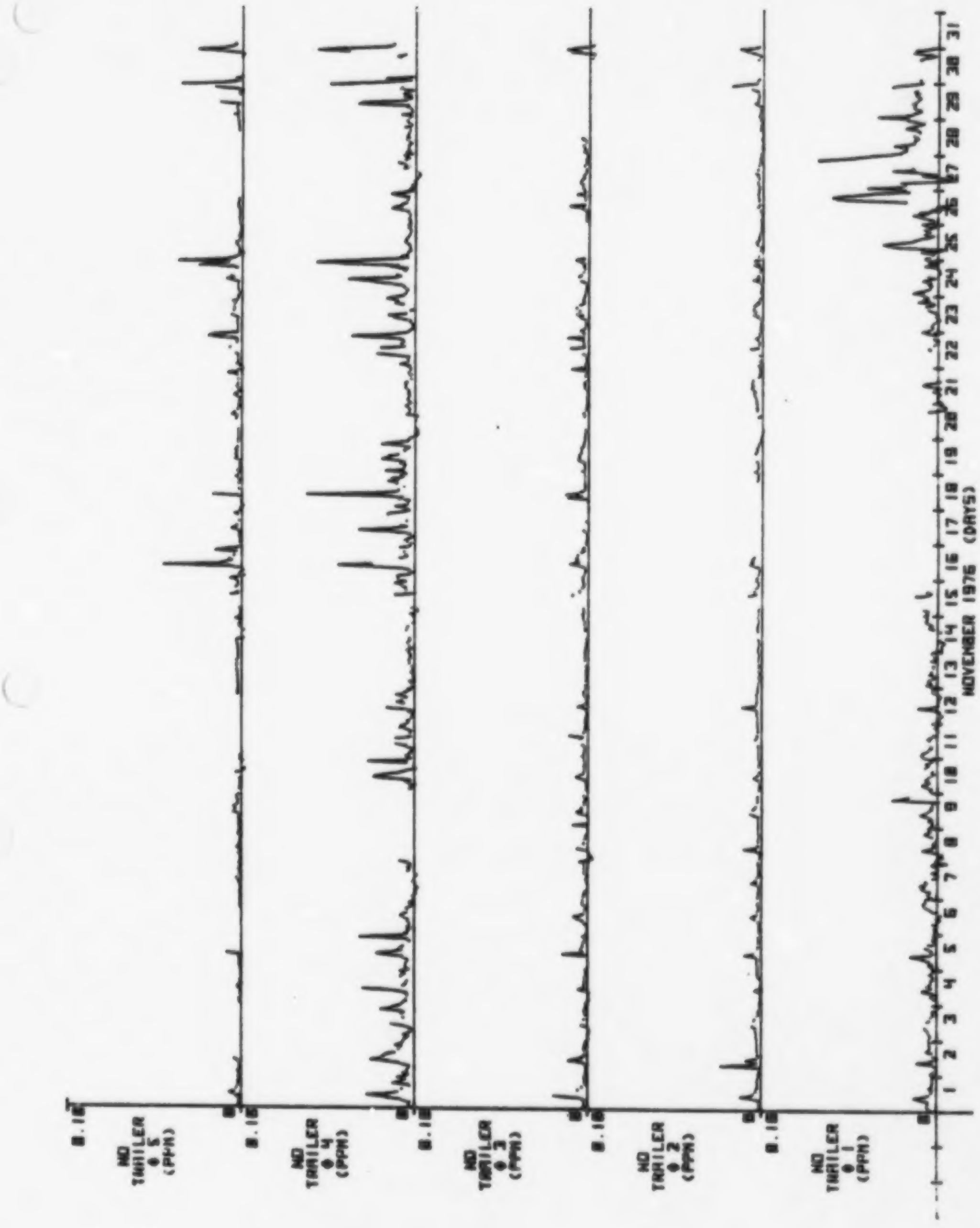

3
CO TRAILER # 5 (PPM)
0
3
CO TRAILER # 4 (PPM)
0
3
CO TRAILER # 3 (PPM)
0
3
CO TRAILER # 2 (PPM)
0
3
CO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NOVEMBER 1976 (DAYS)

Figure H-36.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0.10
NO TRAILER # 4 (PPM)
0
0.10
NO TRAILER # 3 (PPM)
0
0.10
NO TRAILER # 2 (PPM)
0
0.10
NO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NOVEMBER 1976 (DAYS)

Figure H-37.

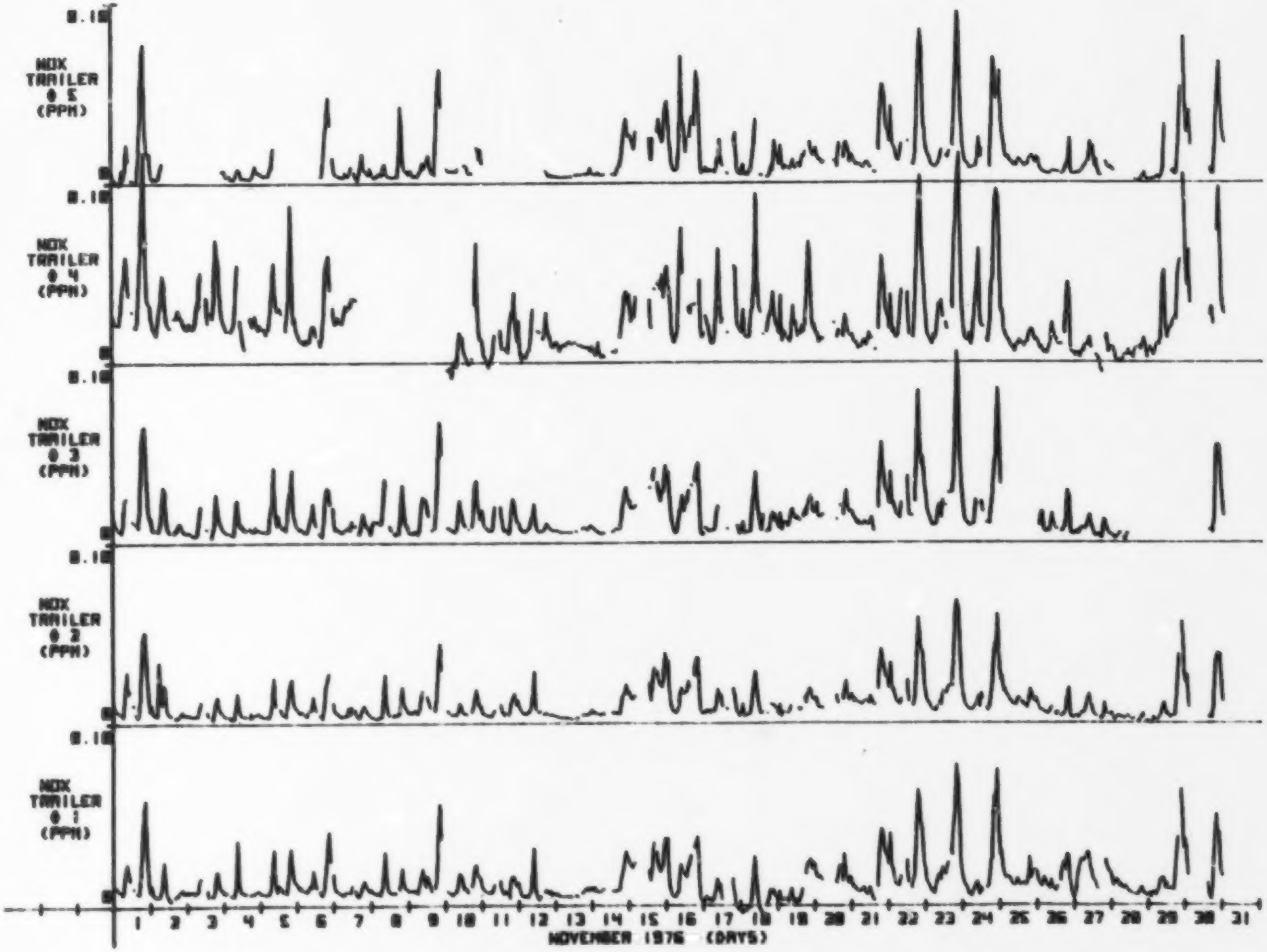

0.10
NOX
TRAILER
# 5
(PPM)
0
0.10
NOX
TRAILER
# 4
(PPM)
0
0.10
NOX
TRAILER
# 3
(PPM)
0
0.10
NOX
TRAILER
# 2
(PPM)
0
0.10
NOX
TRAILER
# 1
(PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NOVEMBER 1976 (DAYS)

Figure H-38.

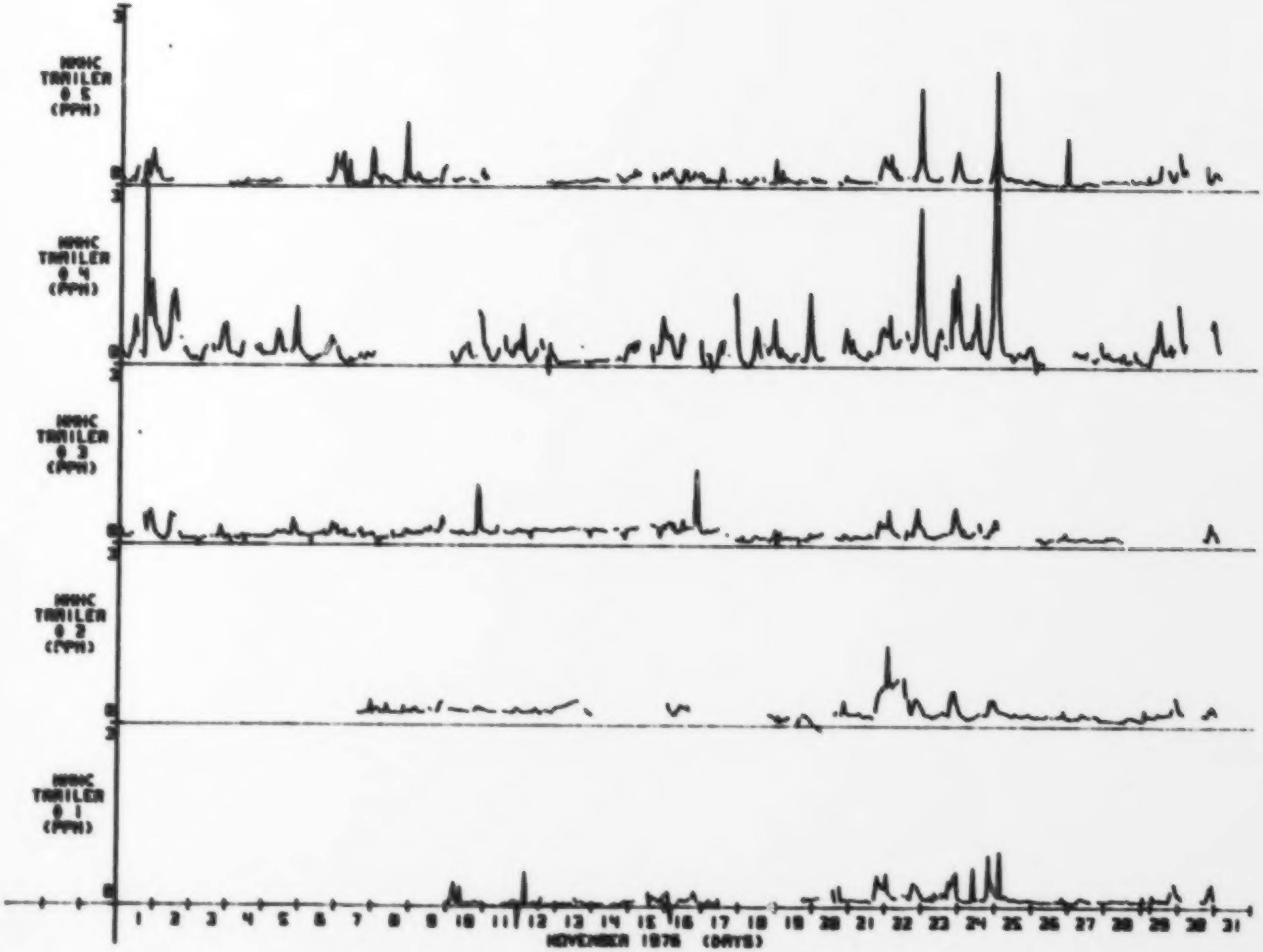

NMHC TRAILER # 5 (PPM)
NMHC TRAILER # 4 (PPM)
NMHC TRAILER # 3 (PPM)
NMHC TRAILER # 2 (PPM)
NMHC TRAILER # 1 (PPM)
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NOVEMBER 1976 (DAYS)

Figure H-39.

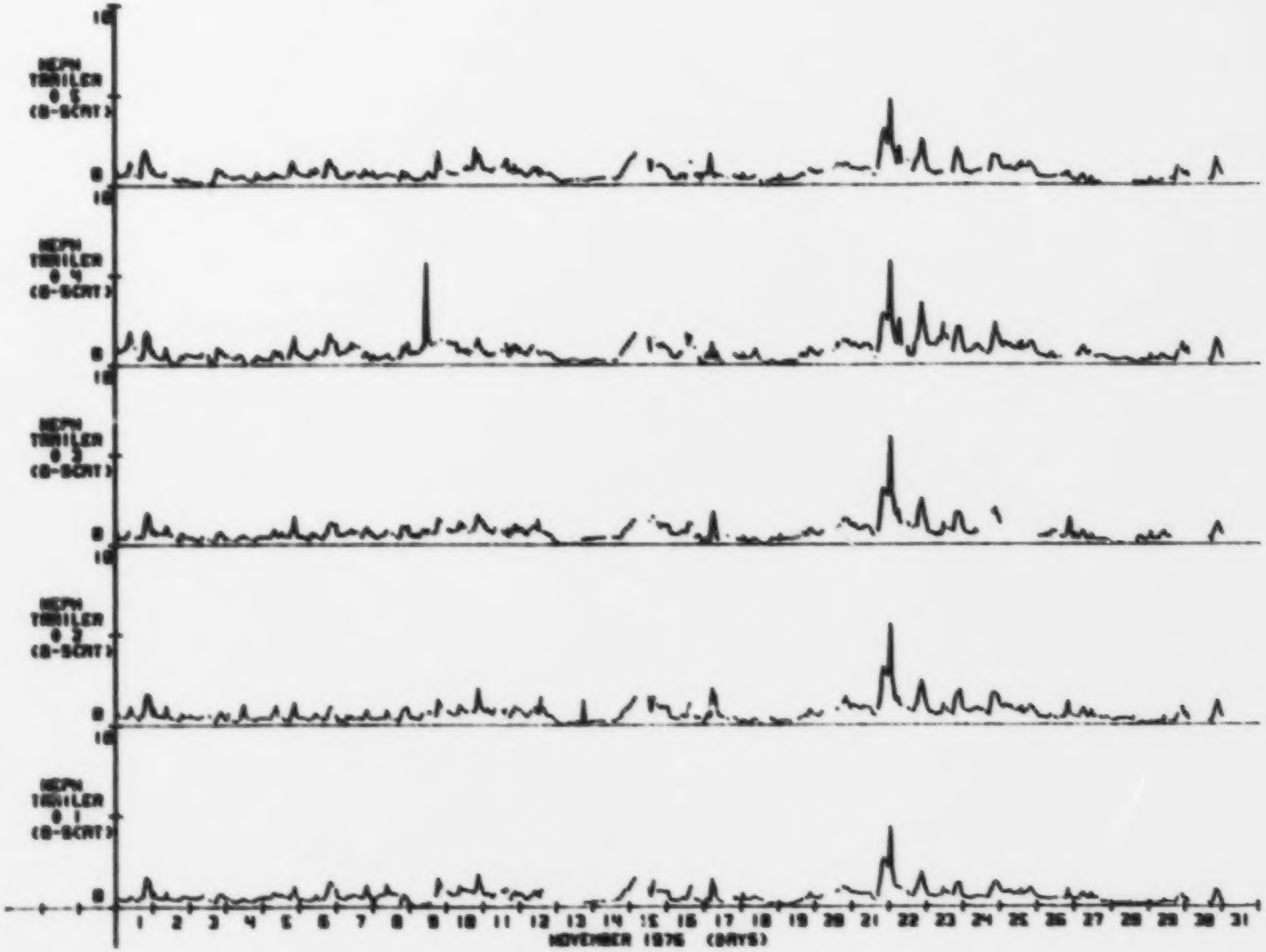
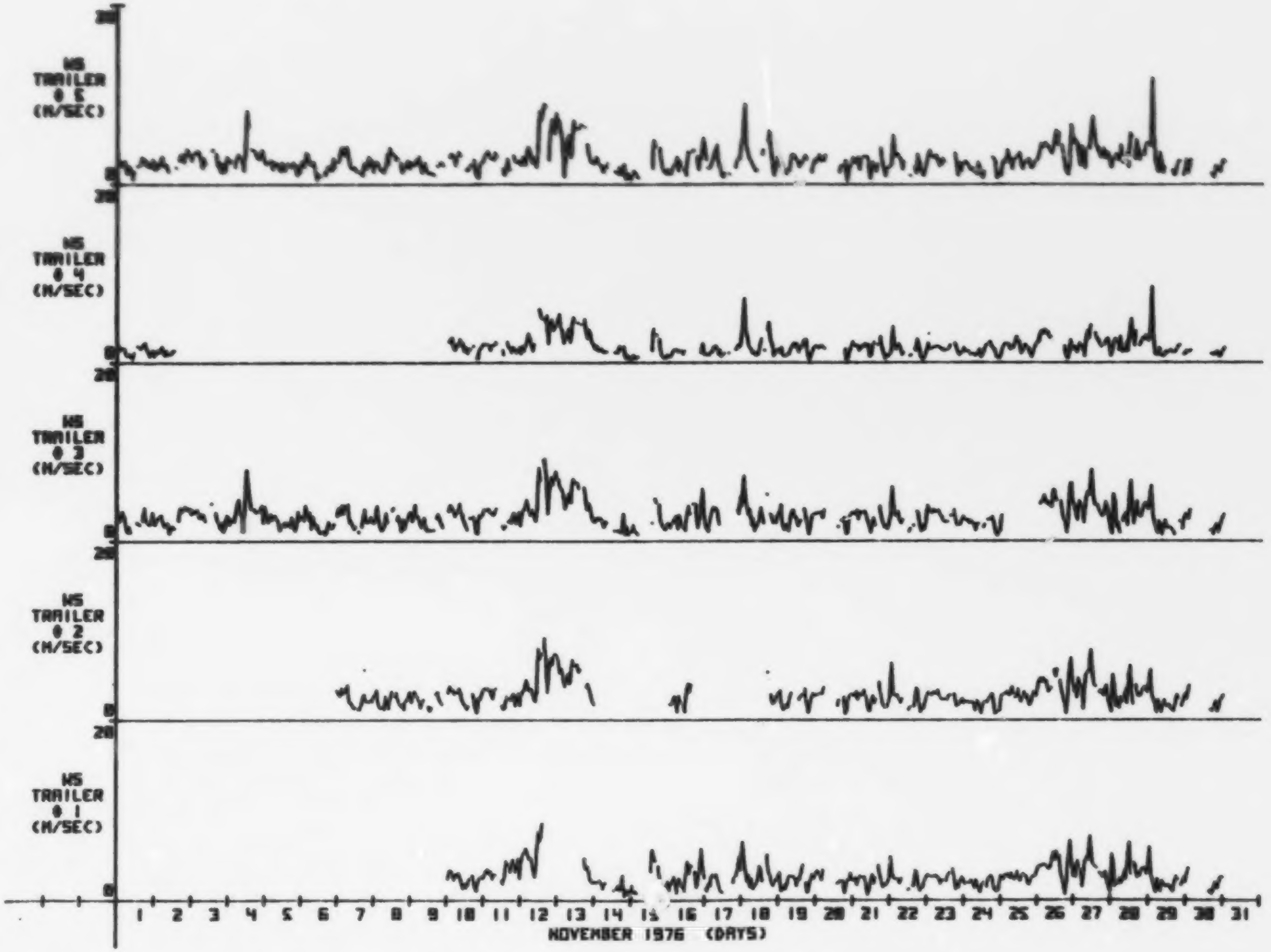

10
NEPH
TRAILER
0 5
(B-SCAT)
0
10
NEPH
TRAILER
0 4
(B-SCAT)
0
10
NEPH
TRAILER
0 3
(B-SCAT)
0
10
NEPH
TRAILER
0 2
(B-SCAT)
0
10
NEPH
TRAILER
0 1
(B-SCAT)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NOVEMBER 1976 (DAYS)

Figure H-40.


20
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TRAILER
# 5
(M/SEC)
0
20
WS
TRAILER
# 4
(M/SEC)
0
20
WS
TRAILER
# 3
(M/SEC)
0
20
WS
TRAILER
# 2
(M/SEC)
0
20
WS
TRAILER
# 1
(M/SEC)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NOVEMBER 1976 (DAYS)

Figure H-41.

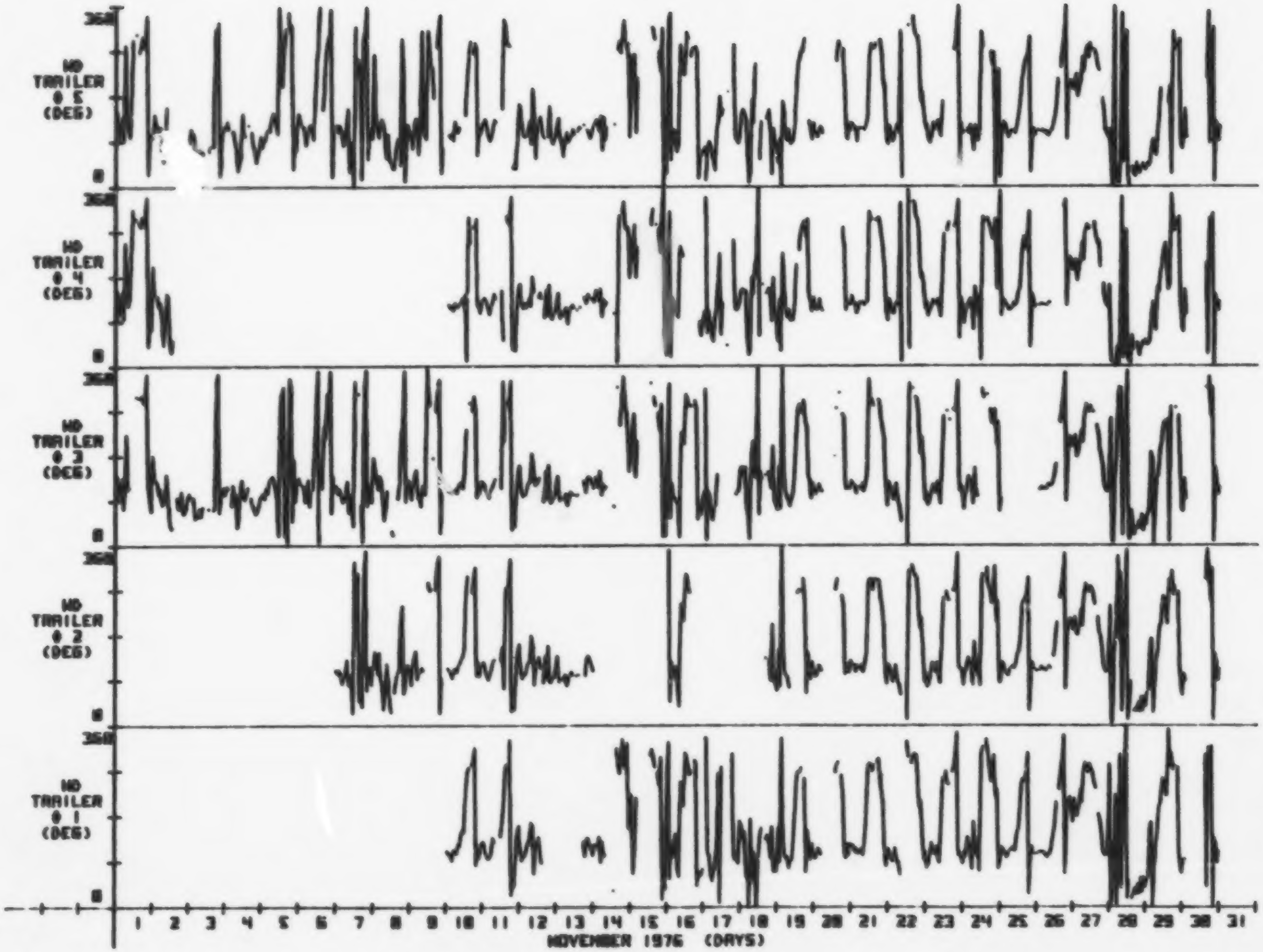

360
WD
TRAILER
# 5
(DEG)
0
360
WD
TRAILER
# 4
(DEG)
0
360
WD
TRAILER
# 3
(DEG)
0
360
WD
TRAILER
# 2
(DEG)
0
360
WD
TRAILER
# 1
(DEG)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NOVEMBER 1976 (DAYS)

Figure H-42.

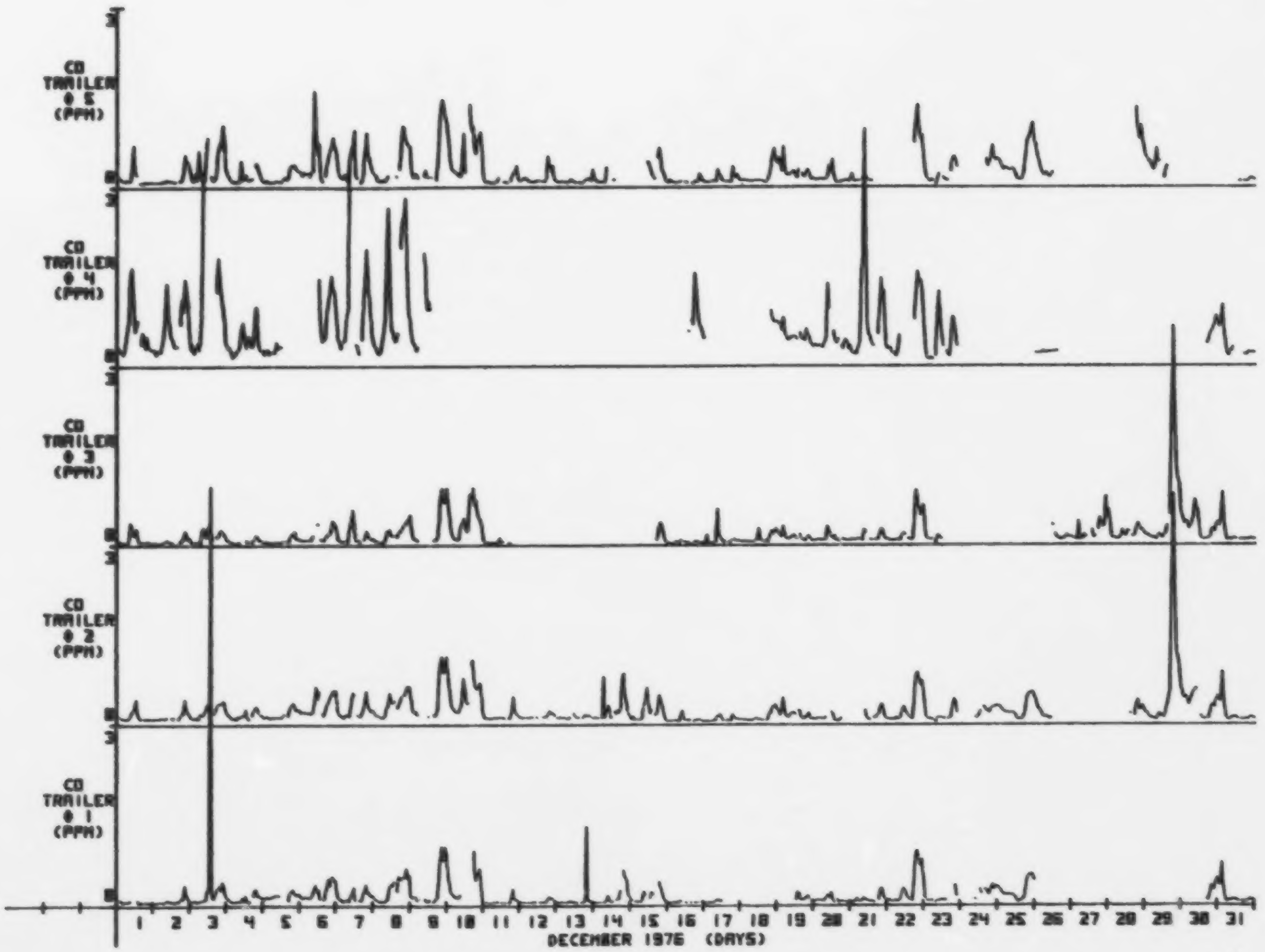

CO TRAILER # 5 (PPM)
CO TRAILER # 4 (PPM)
CO TRAILER # 3 (PPM)
CO TRAILER # 2 (PPM)
CO TRAILER # 1 (PPM)
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DECEMBER 1976 (DAYS)

Figure H-43.

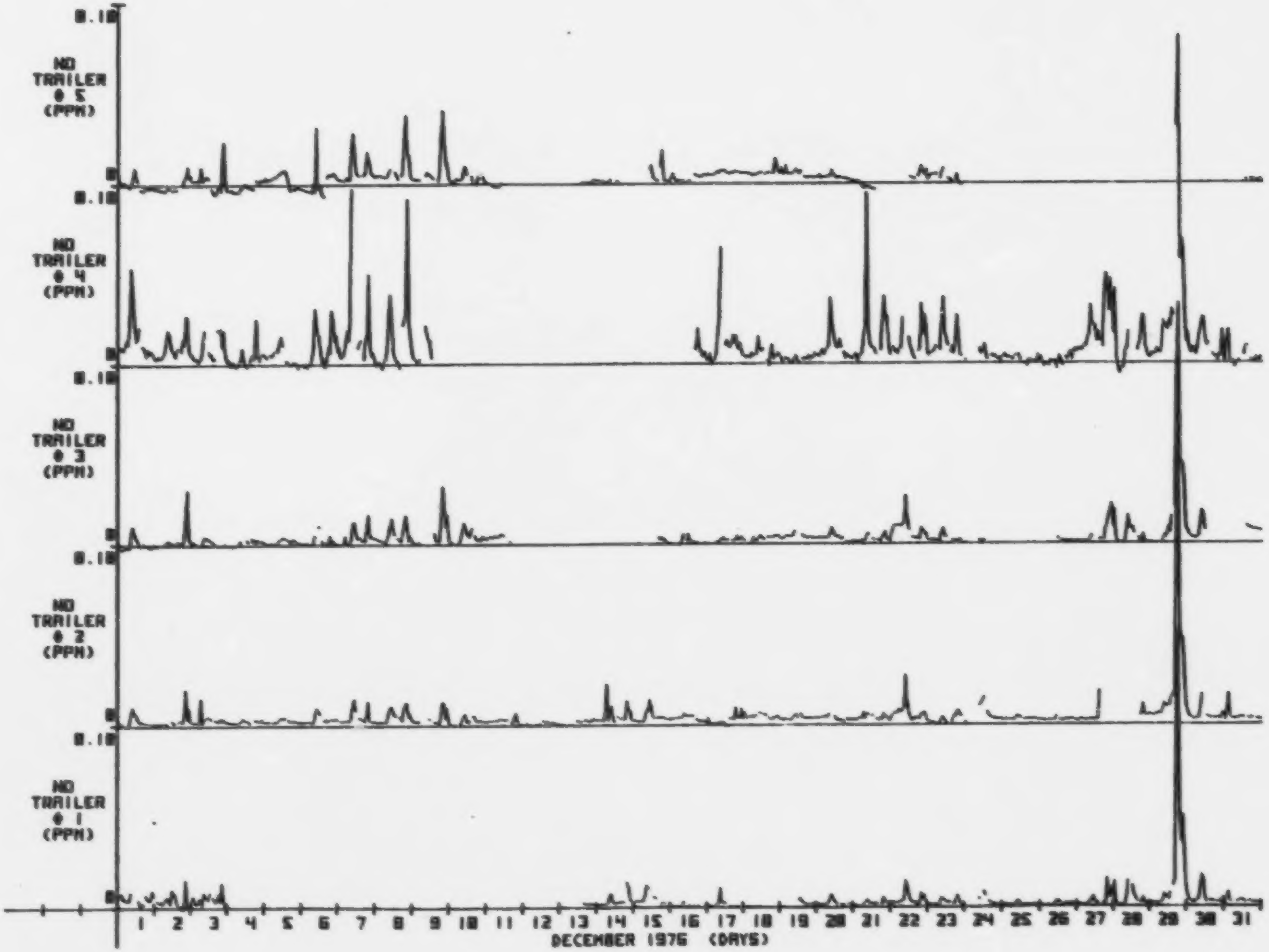

0.10
NO
TRAILER
# 5
(PPM)
0
0.10
NO
TRAILER
# 4
(PPM)
0
0.10
NO
TRAILER
# 3
(PPM)
0
0.10
NO
TRAILER
# 2
(PPM)
0
0.10
NO
TRAILER
# 1
(PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DECEMBER 1976 (DAYS)

Figure H-44.

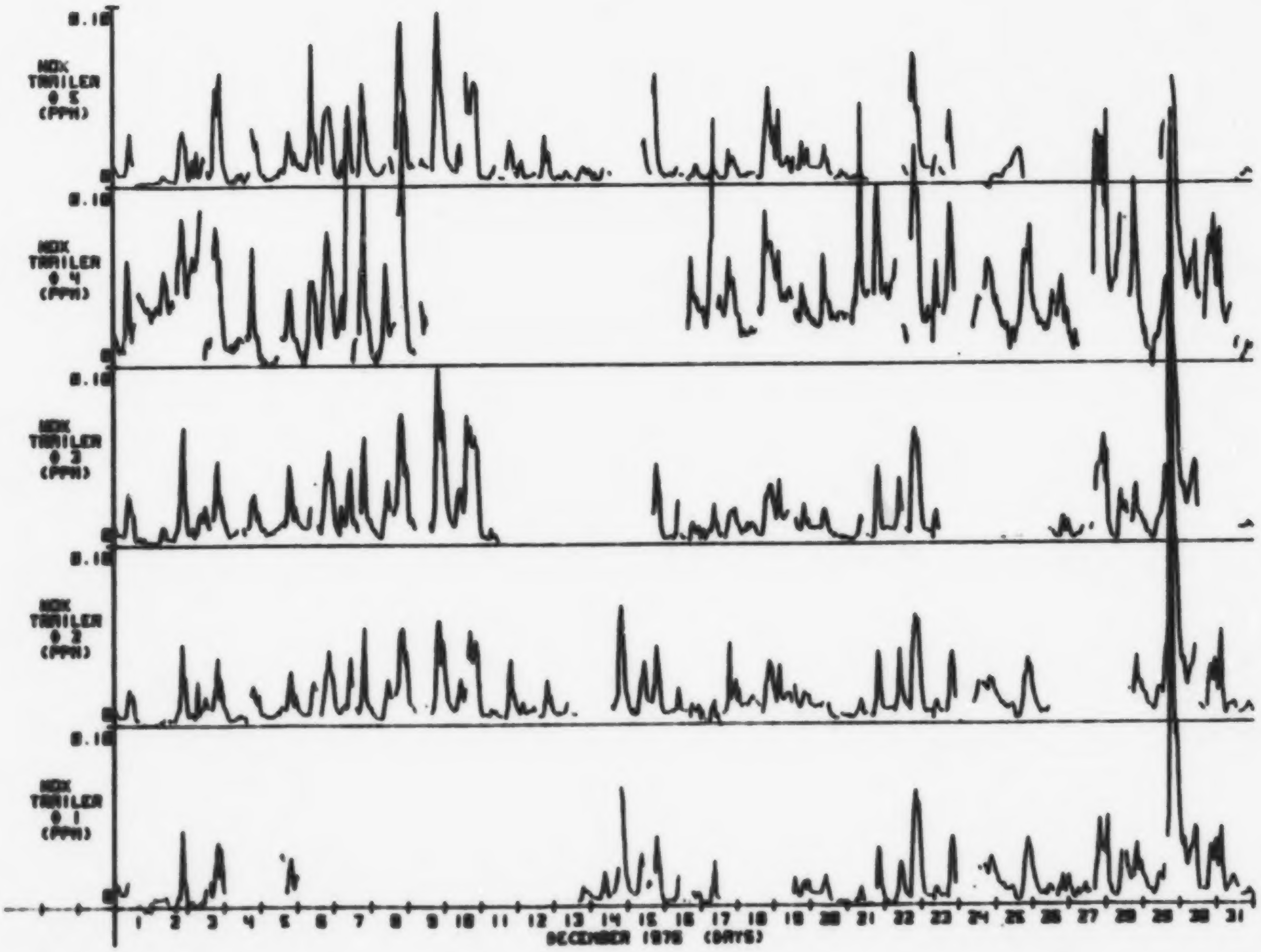

0.10
NOX TRAILER # 5 (PPM)
0
0.10
NOX TRAILER # 4 (PPM)
0
0.10
NOX TRAILER # 3 (PPM)
0
0.10
NOX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DECEMBER 1978 (DAYS)

Figure H-45.

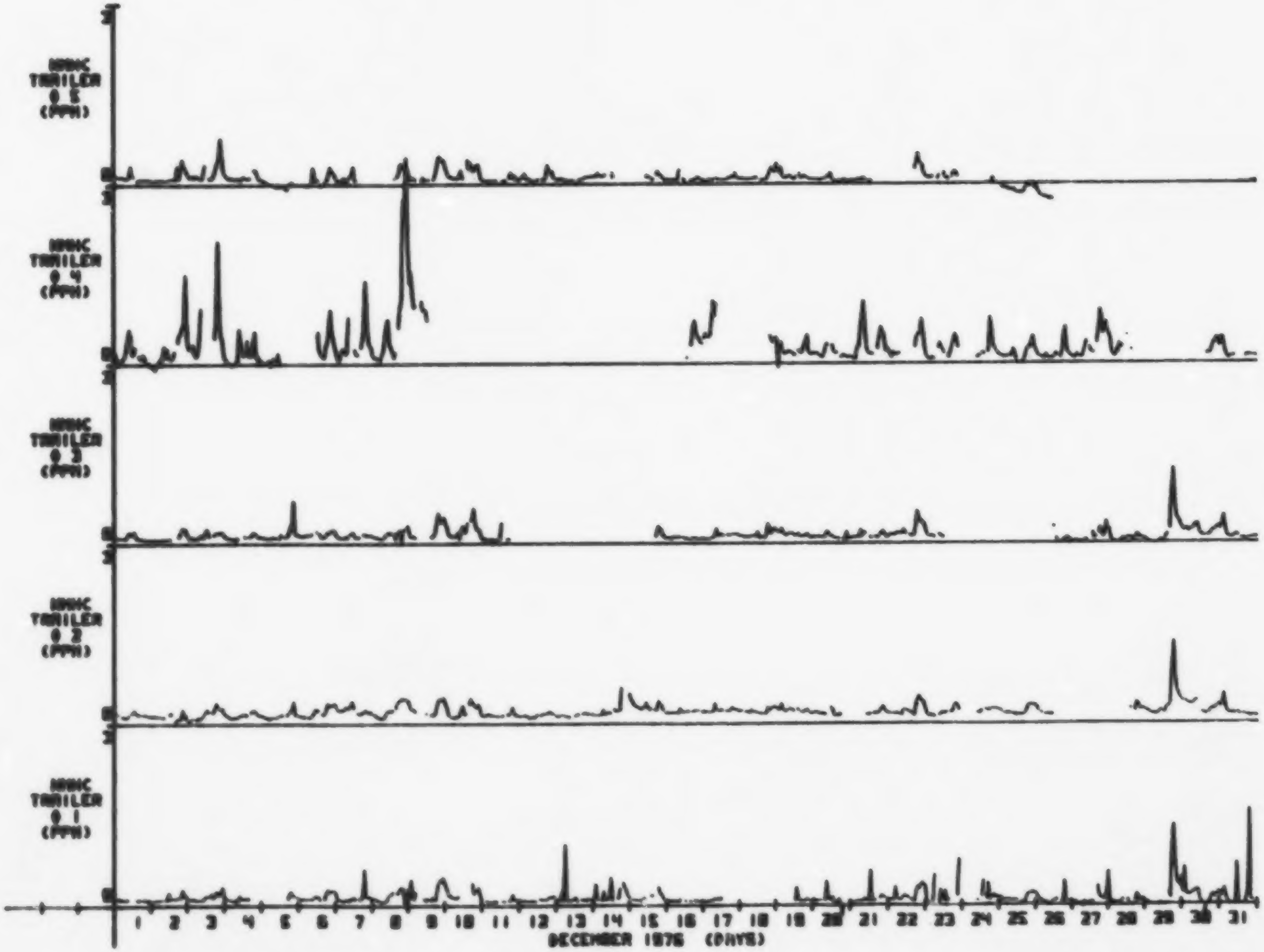

NMHC TRAILER 0 5 (PPM)
NMHC TRAILER 0 4 (PPM)
NMHC TRAILER 0 3 (PPM)
NMHC TRAILER 0 2 (PPM)
NMHC TRAILER 0 1 (PPM)
2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DECEMBER 1976 (DAYS)

Figure H-46.

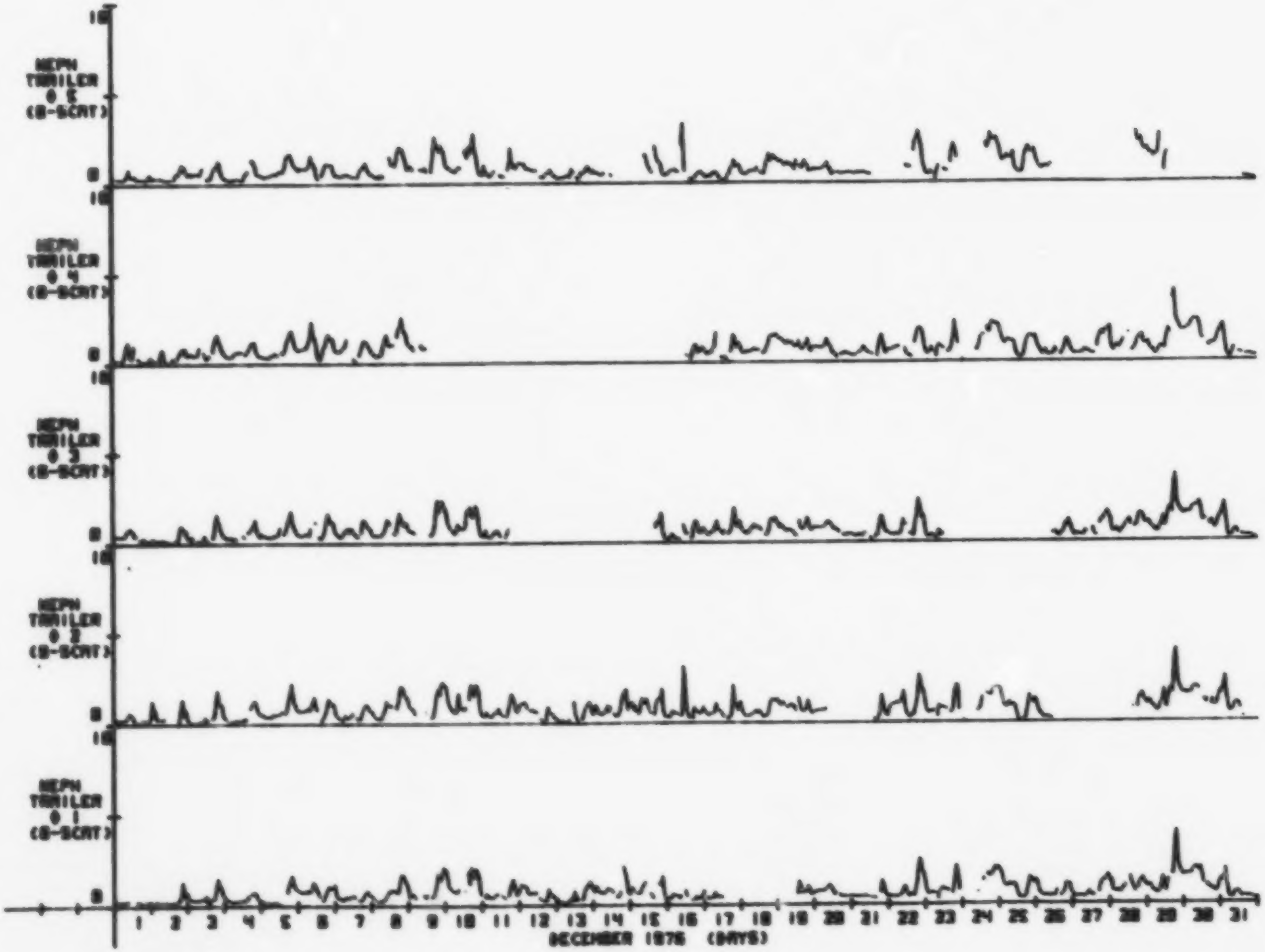

10
NEPH TRAILER # 5 (B-SCAT)
0
10
NEPH TRAILER # 4 (B-SCAT)
0
10
NEPH TRAILER # 3 (B-SCAT)
0
10
NEPH TRAILER # 2 (B-SCAT)
0
10
NEPH TRAILER # 1 (B-SCAT)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DECEMBER 1976 (DAYS)

Figure H-47.

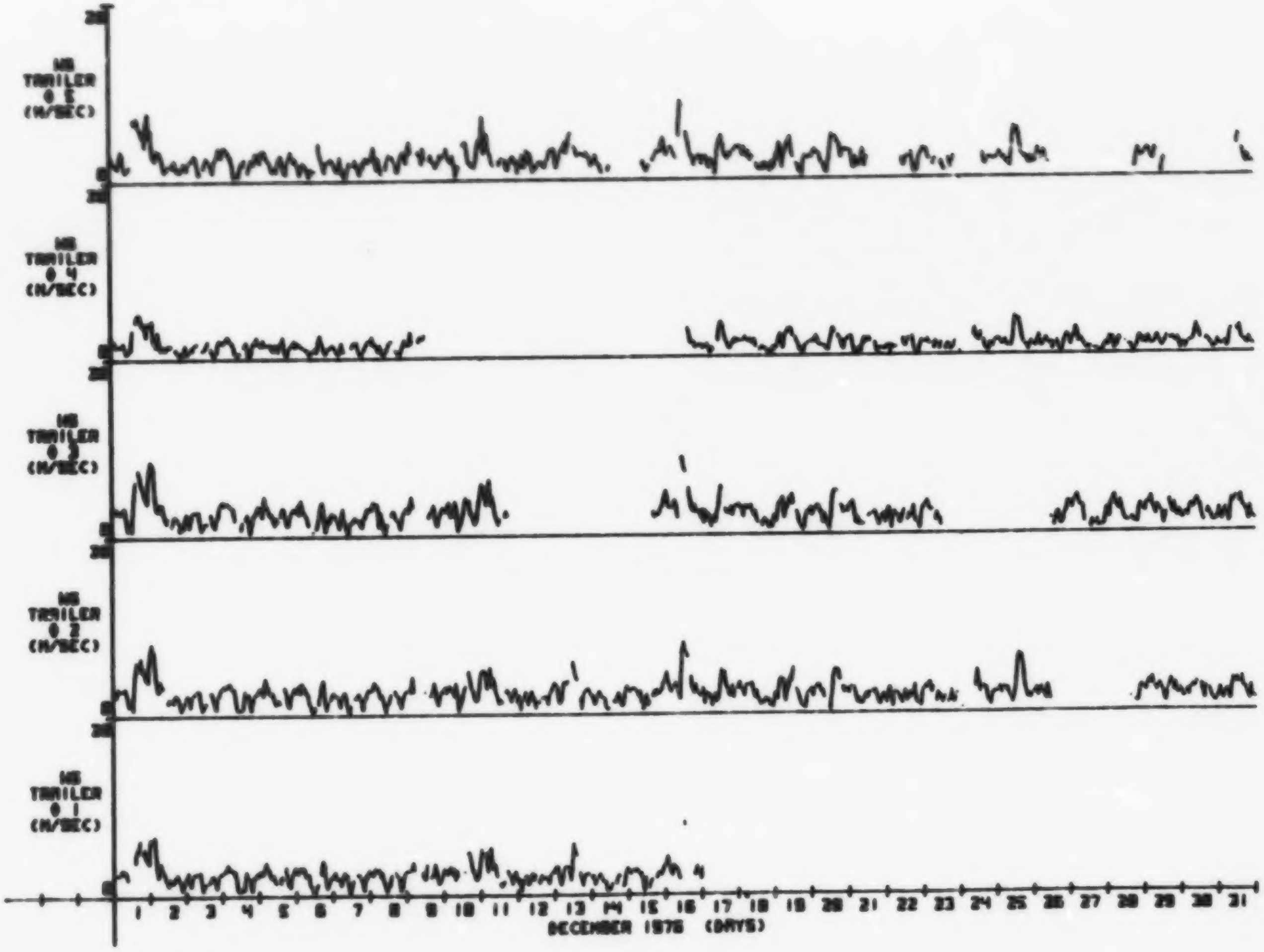

20
WS TRAILER @ 5 (M/SEC)
0
20
WS TRAILER @ 4 (M/SEC)
0
20
WS TRAILER @ 3 (M/SEC)
0
20
WS TRAILER @ 2 (M/SEC)
0
20
WS TRAILER @ 1 (M/SEC)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DECEMBER 1976 (DAYS)

Figure H-48.

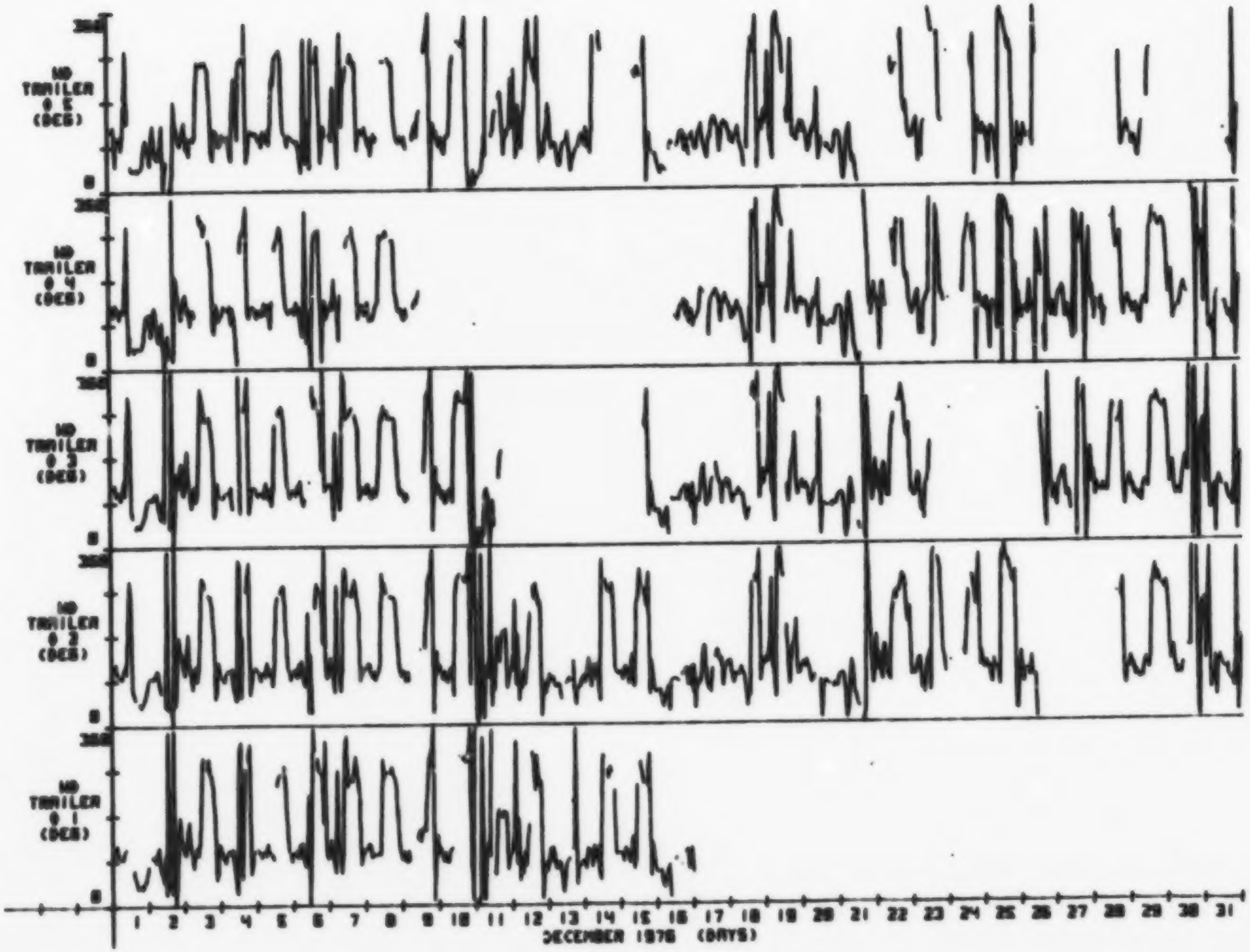

360
WD TRAILER # 5 (DEG)
0
360
WD TRAILER # 4 (DEG)
0
360
WD TRAILER # 3 (DEG)
0
360
WD TRAILER # 2 (DEG)
0
360
WD TRAILER # 1 (DEG)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DECEMBER 1976 (DAYS)

Figure H-49.

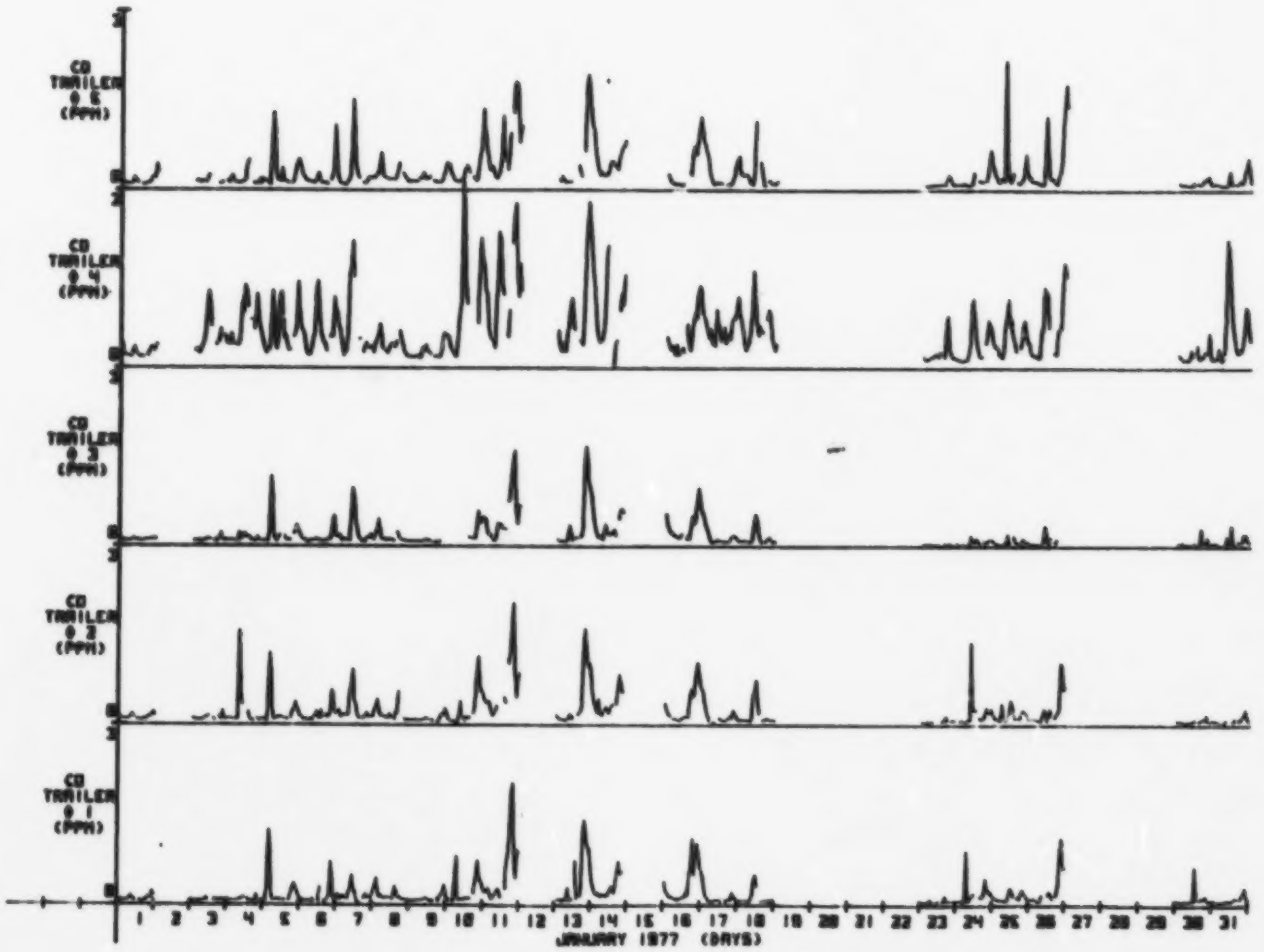

2
CO TRAILER # 5 (PPM)
0
2
CO TRAILER # 4 (PPM)
0
2
CO TRAILER # 3 (PPM)
0
2
CO TRAILER # 2 (PPM)
0
2
CO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JANUARY 1977 (DAYS)

Figure H-50.

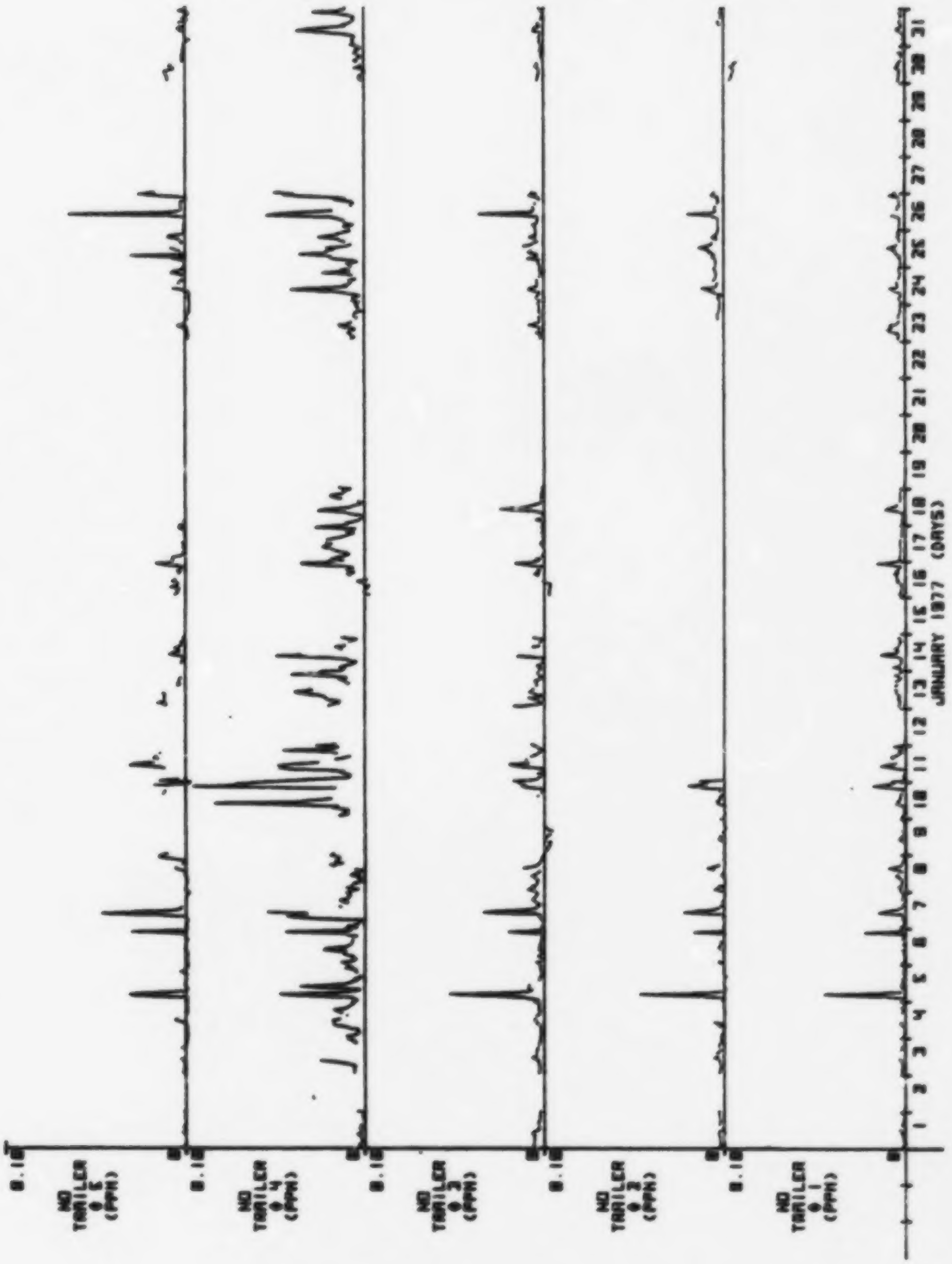

0.10
NO TRAILER # 5 (PPM)
0
0.10
NO TRAILER # 4 (PPM)
0
0.10
NO TRAILER # 3 (PPM)
0
0.10
NO TRAILER # 2 (PPM)
0
0.10
NO TRAILER # 1 (PPM)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
JANUARY 1977 (DAYS)

Figure H-51.

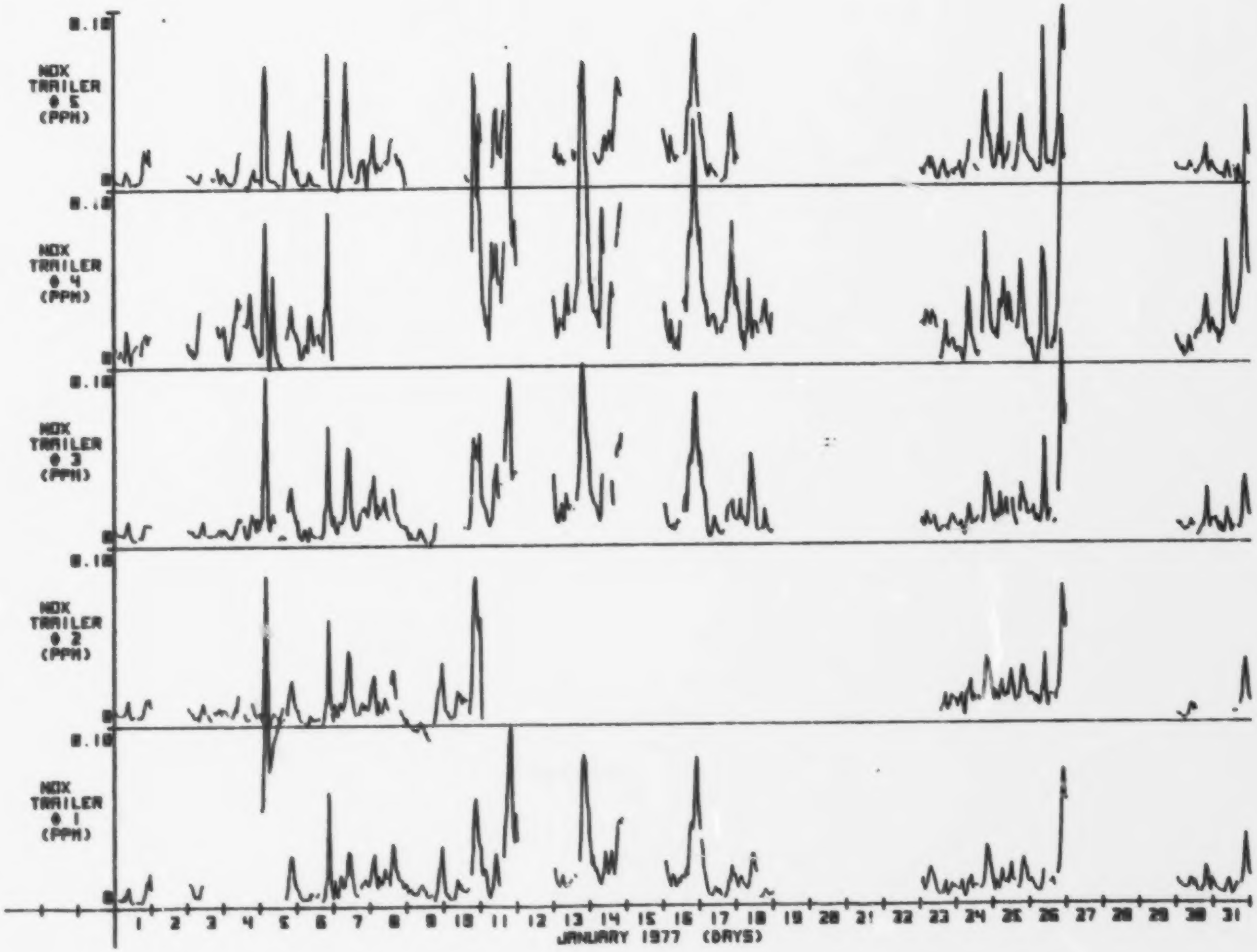

0.10
NOX TRAILER # 5 (PPM)
0
0.10
NOX TRAILER # 4 (PPM)
0
0.10
NOX TRAILER # 3 (PPM)
0
0.10
NOX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JANUARY 1977 (DAYS)

Figure H-52.

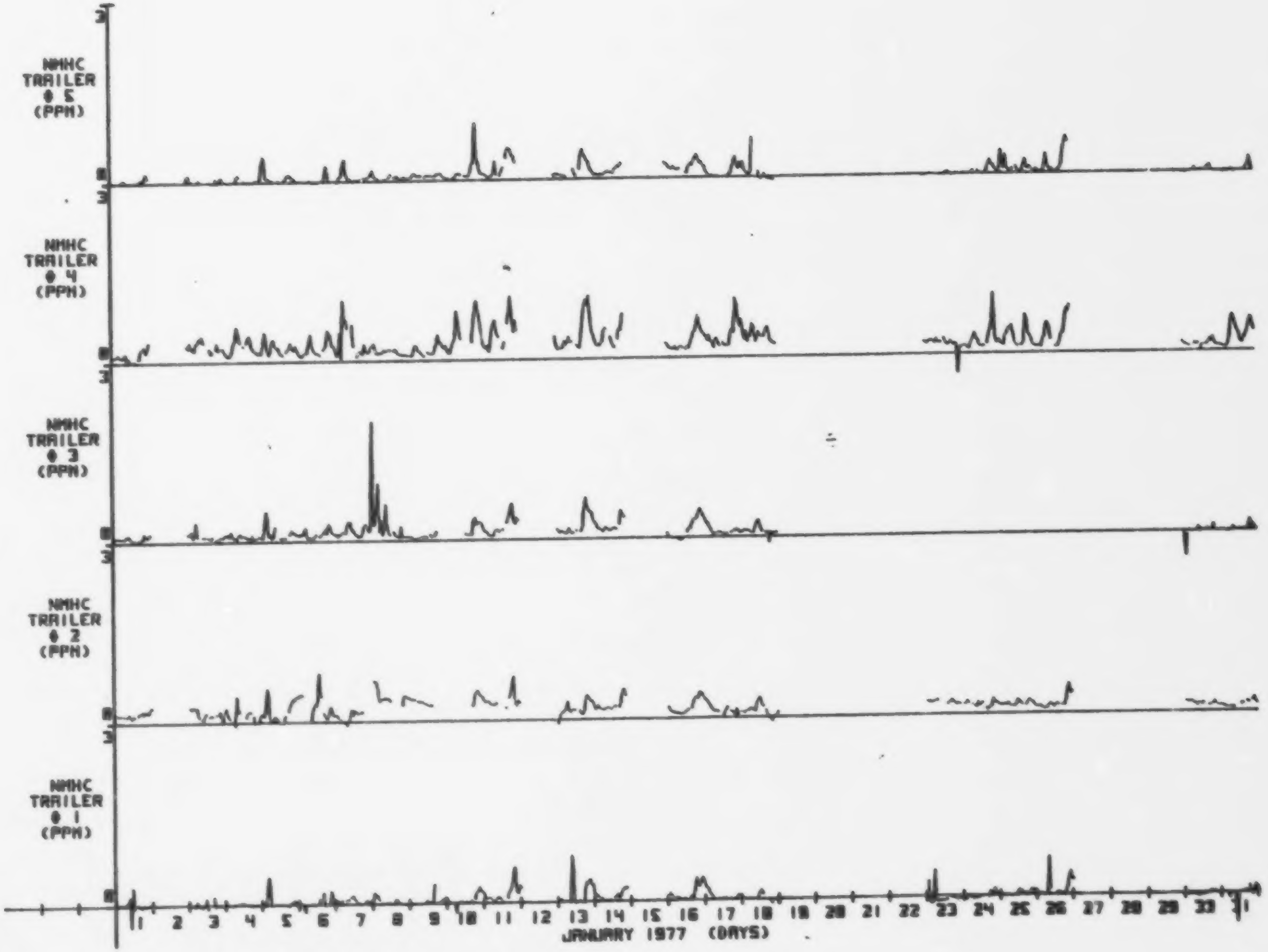

NMHC TRAILER # 5 (PPM)
NMHC TRAILER # 4 (PPM)
NMHC TRAILER # 3 (PPM)
NMHC TRAILER # 2 (PPM)
NMHC TRAILER # 1 (PPM)
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JANUARY 1977 (DAYS)

Figure H-53.

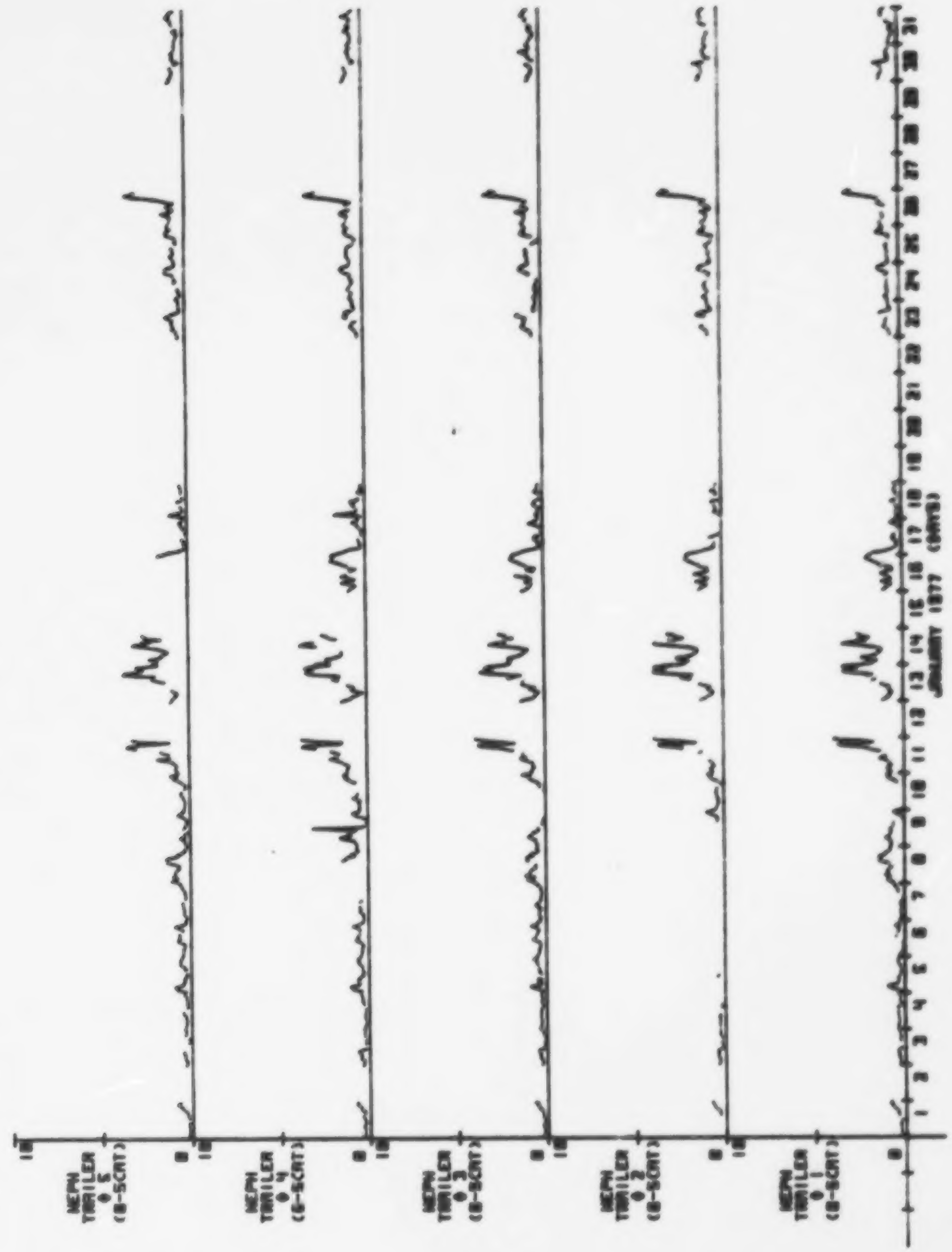

10
NEPH TRAILER # 5 (B-SCAT)
0
10
NEPH TRAILER # 4 (B-SCAT)
0
10
NEPH TRAILER # 3 (B-SCAT)
0
10
NEPH TRAILER # 2 (B-SCAT)
0
10
NEPH TRAILER # 1 (B-SCAT)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JANUARY 1977 (DAYS)

Figure H-54.

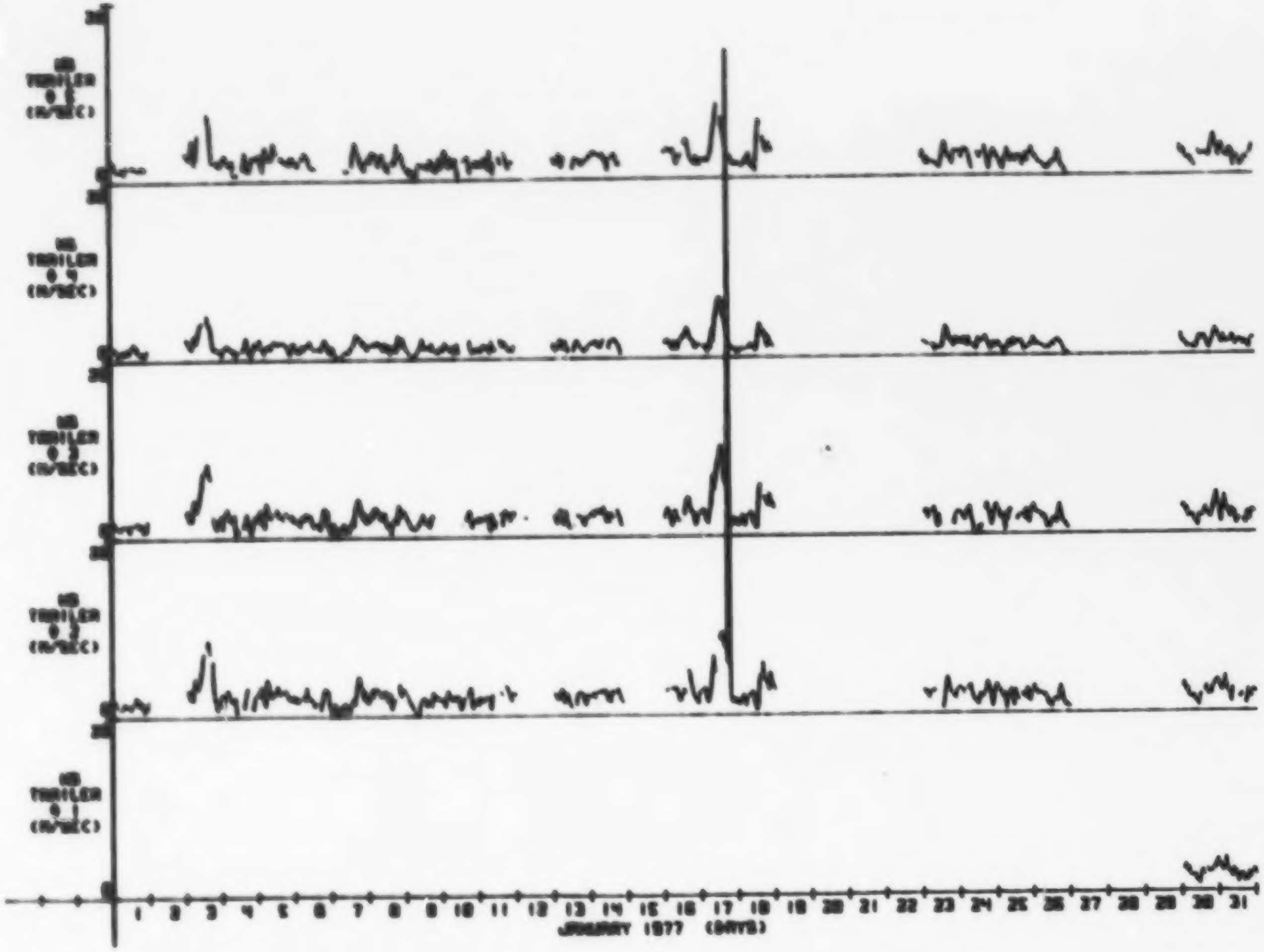

WS TRAILER 0 5 (M/SEC)
WS TRAILER 0 4 (M/SEC)
WS TRAILER 0 3 (M/SEC)
WS TRAILER 0 2 (M/SEC)
WS TRAILER 0 1 (M/SEC)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JANUARY 1977 (DAYS)

Figure H-55.

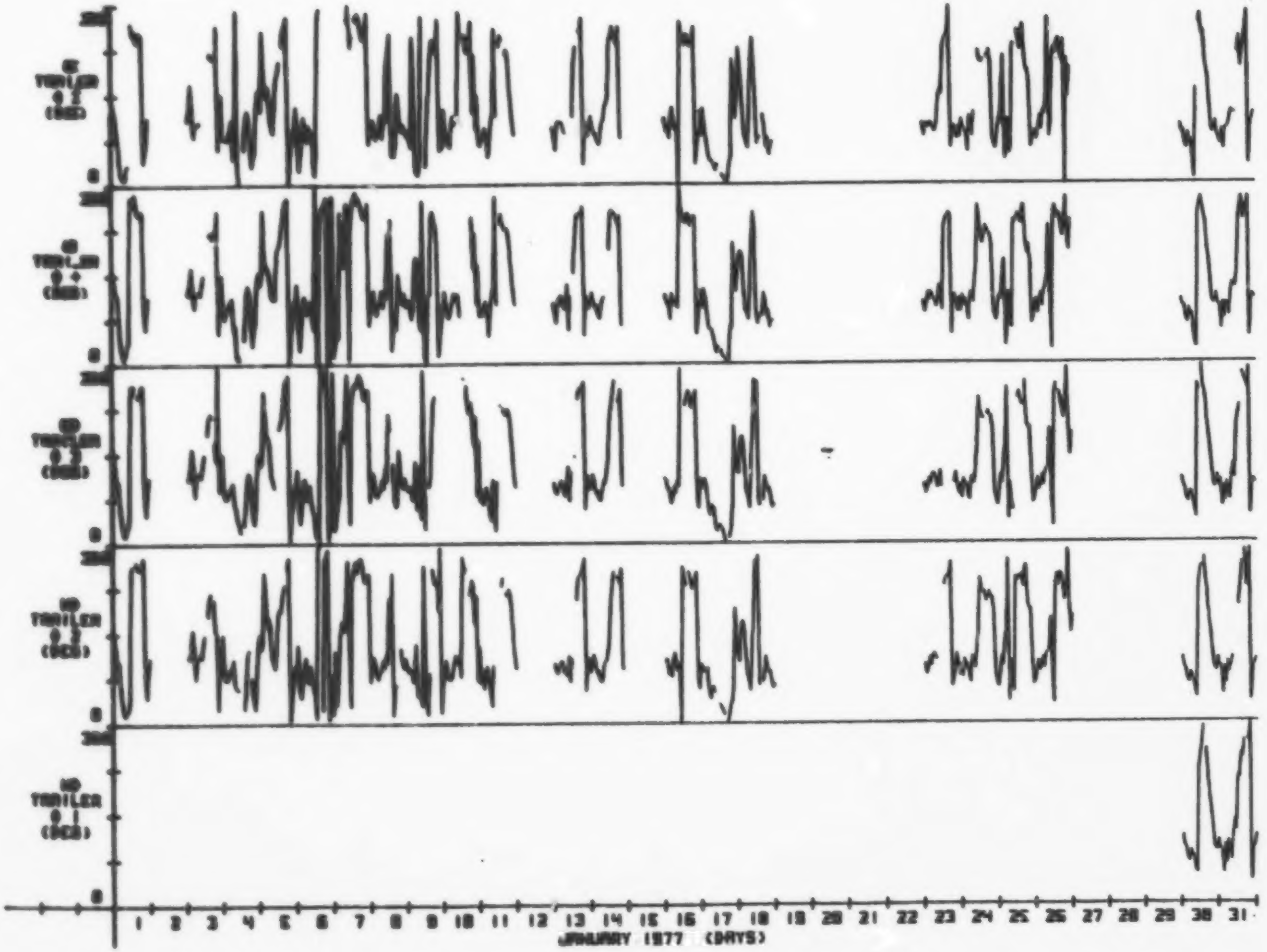

0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
JANUARY 1977 (DAYS)

Figure H-56.

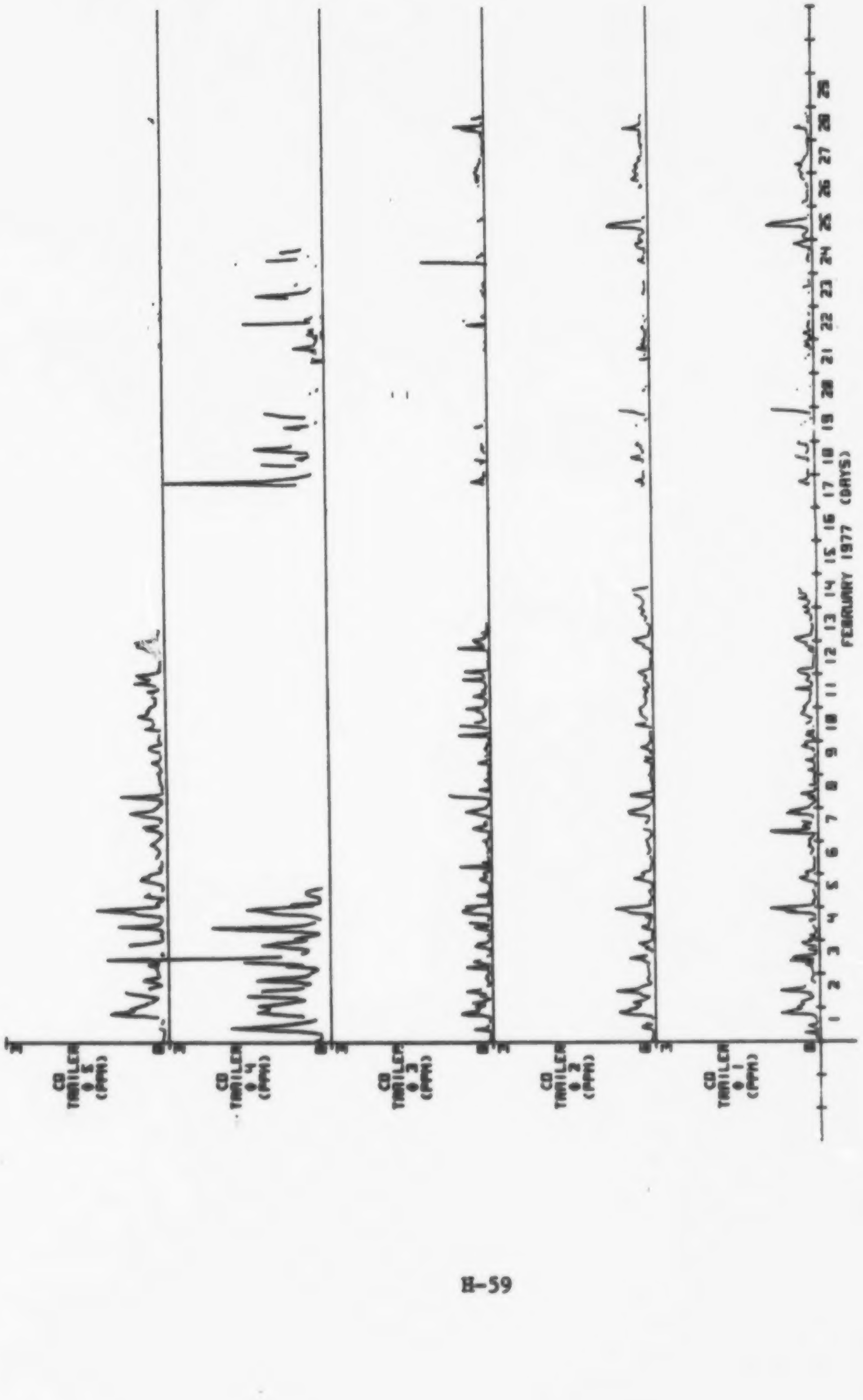

CO TRAILER @ 5 (PPM)
CO TRAILER @ 4 (PPM)
CO TRAILER @ 3 (PPM)
CO TRAILER @ 2 (PPM)
CO TRAILER @ 1 (PPM)
0
3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
FEBRUARY 1977 (DAYS)

Figure H-57.

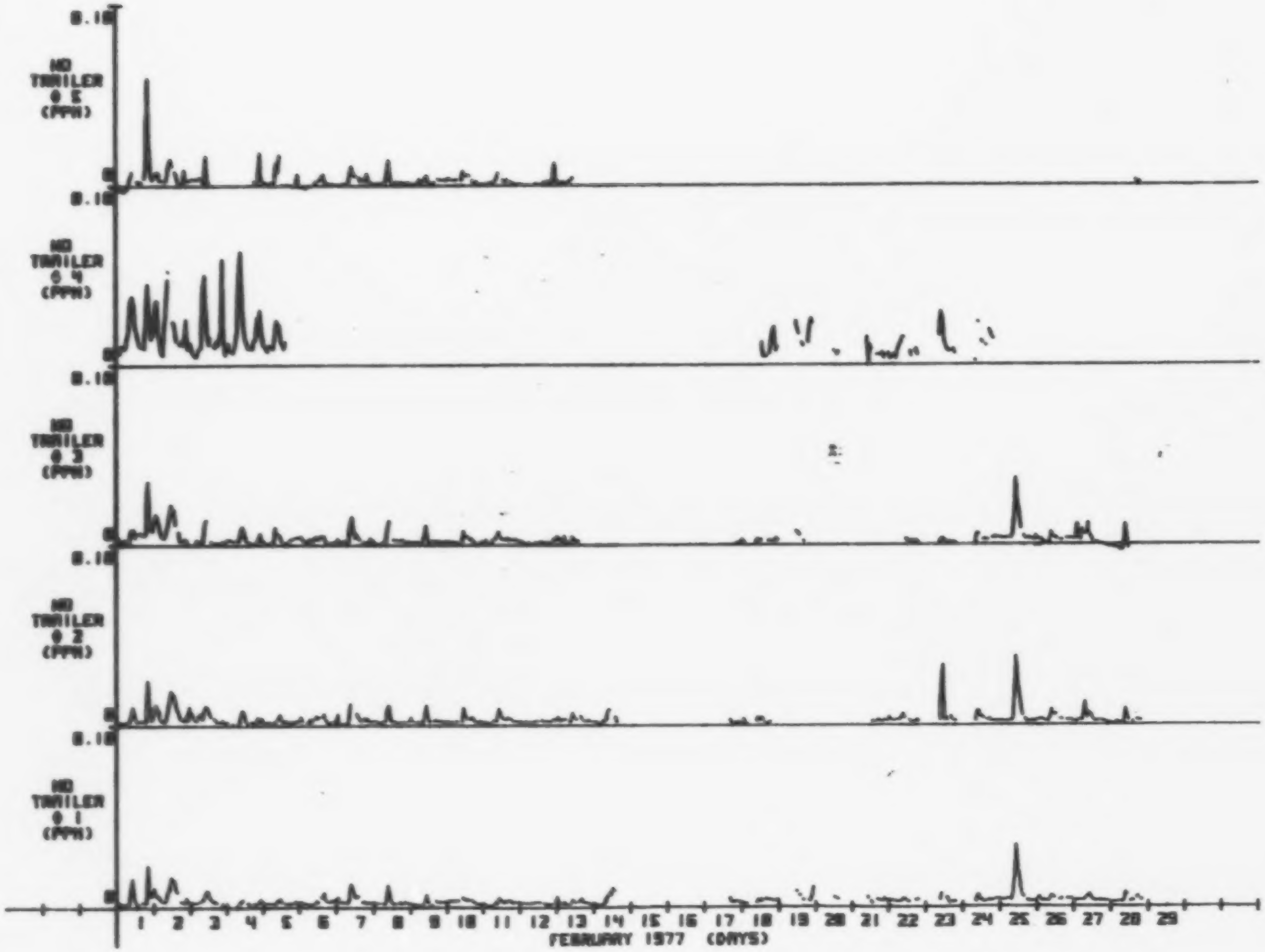

0.10
NO TRAILER # 5 (PPM)
0
0.10
NO TRAILER # 4 (PPM)
0
0.10
NO TRAILER # 3 (PPM)
0
0.10
NO TRAILER # 2 (PPM)
0
0.10
NO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
FEBRUARY 1977 (DAYS)

Figure H-58.

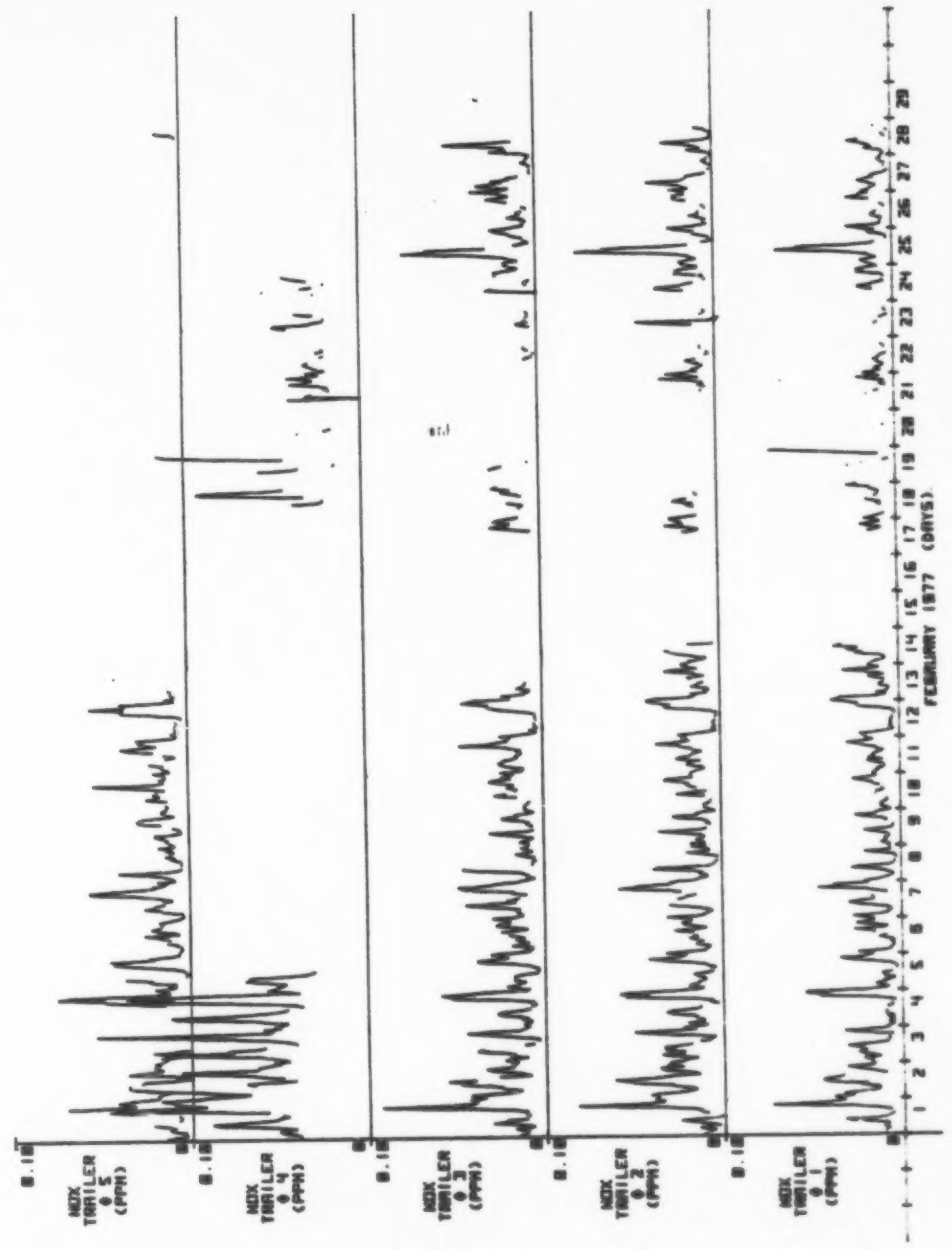

NOX TRAILER # 5 (PPM)
NOX TRAILER # 4 (PPM)
NOX TRAILER # 3 (PPM)
NOX TRAILER # 2 (PPM)
NOX TRAILER # 1 (PPM)
0.10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
FEBRUARY 1977 (DAYS)

Figure H-59.

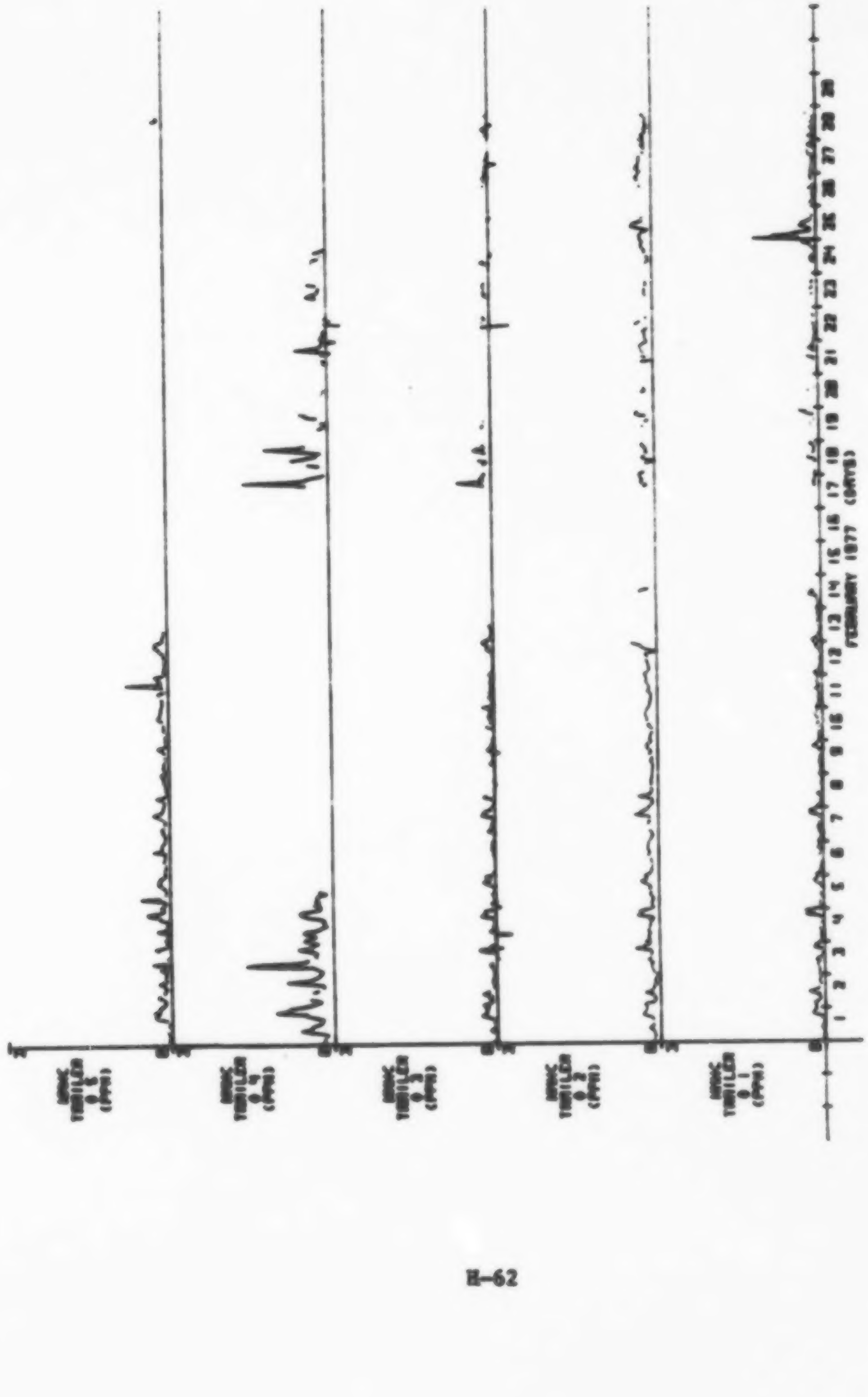

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
FEBRUARY 1977 (DAYS)

Figure H-60.

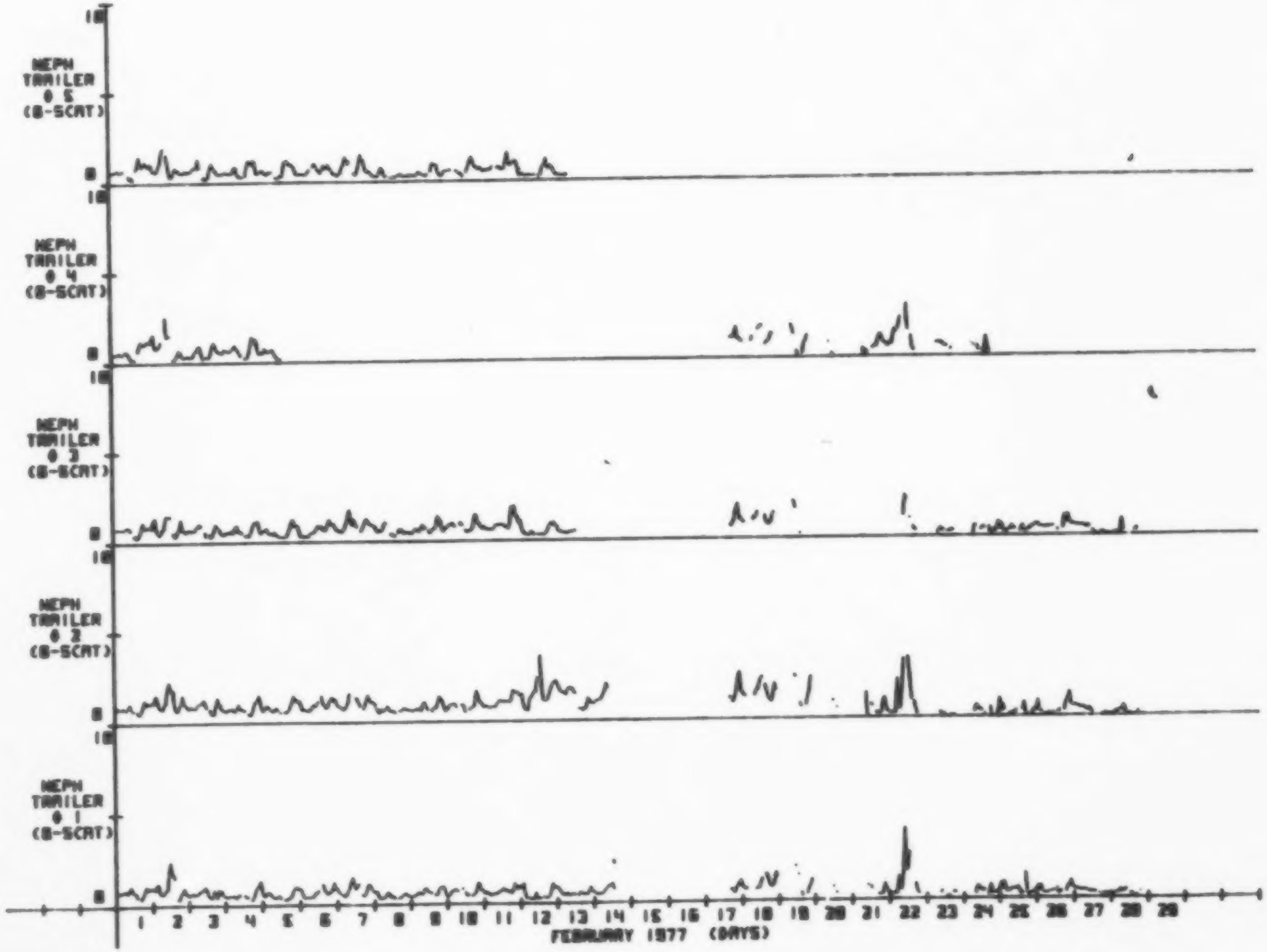

10
NEPH
TRAILER
# 5
(B-SCAT)
0
10
NEPH
TRAILER
# 4
(B-SCAT)
0
10
NEPH
TRAILER
# 3
(B-SCAT)
0
10
NEPH
TRAILER
# 2
(B-SCAT)
0
10
NEPH
TRAILER
# 1
(B-SCAT)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
FEBRUARY 1977 (DAYS)

Figure H-61.

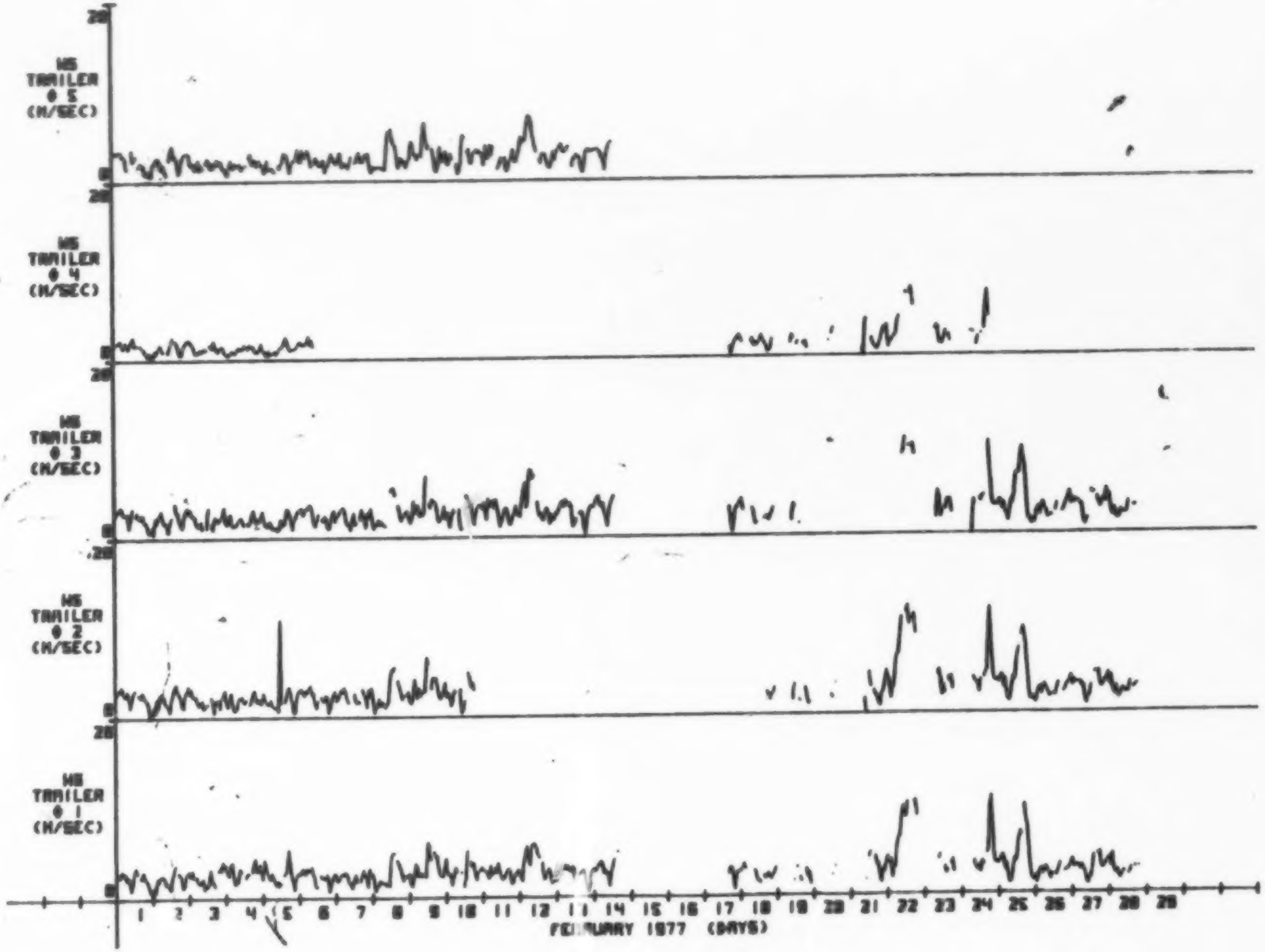

20
WS TRAILER # 5 (M/SEC)
0
20
WS TRAILER # 4 (M/SEC)
0
20
WS TRAILER # 3 (M/SEC)
0
20
WS TRAILER # 2 (M/SEC)
0
20
WS TRAILER # 1 (M/SEC)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
FEBRUARY 1977 (DAYS)

Figure H-62.

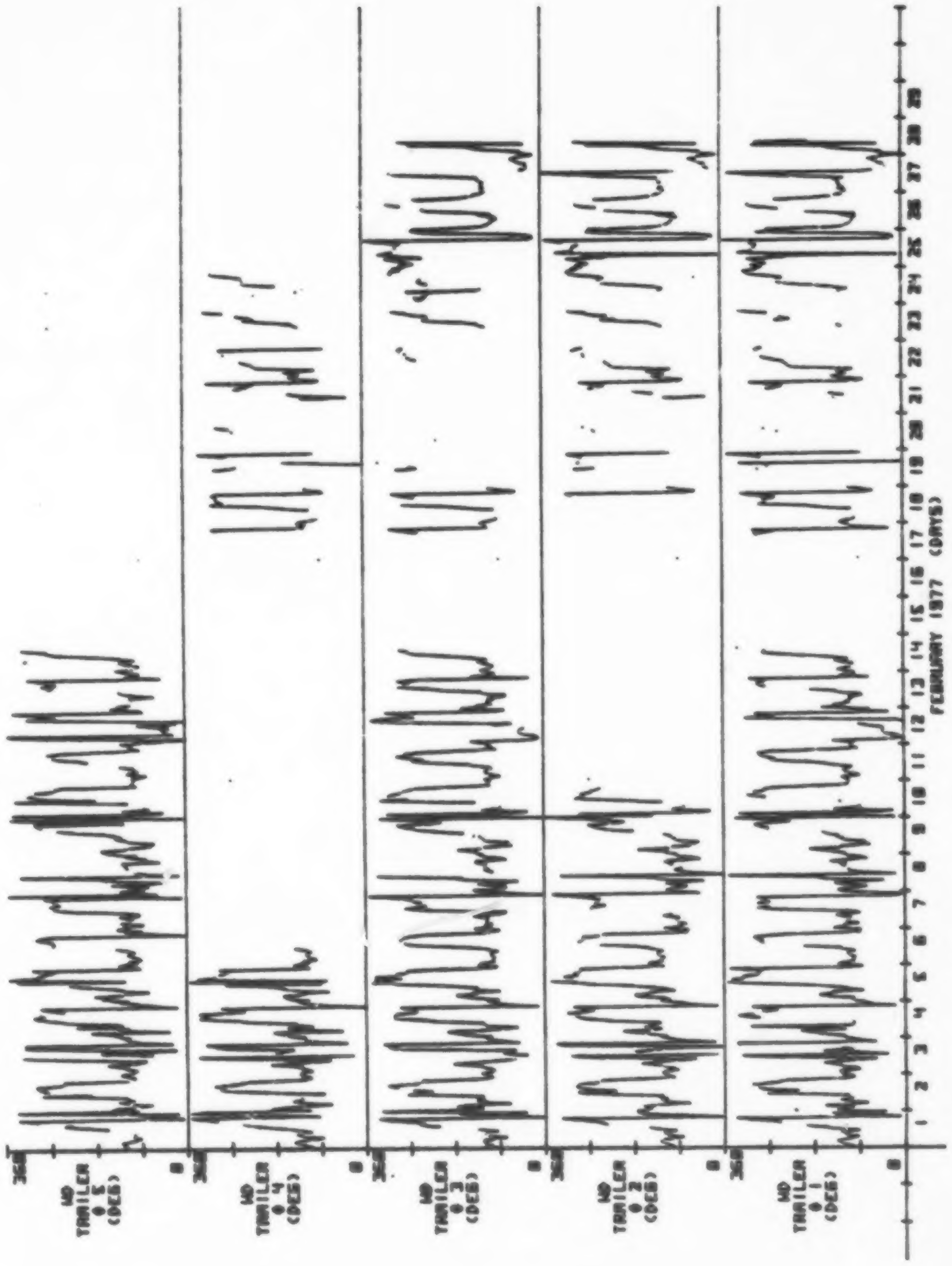

360
WD TRAILER θ 5 (DEG)
0
360
WD TRAILER θ 4 (DEG)
0
360
WD TRAILER θ 3 (DEG)
0
360
WD TRAILER θ 2 (DEG)
0
360
WD TRAILER θ 1 (DEG)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
FEBRUARY 1977 (DAYS)

Figure H-63.

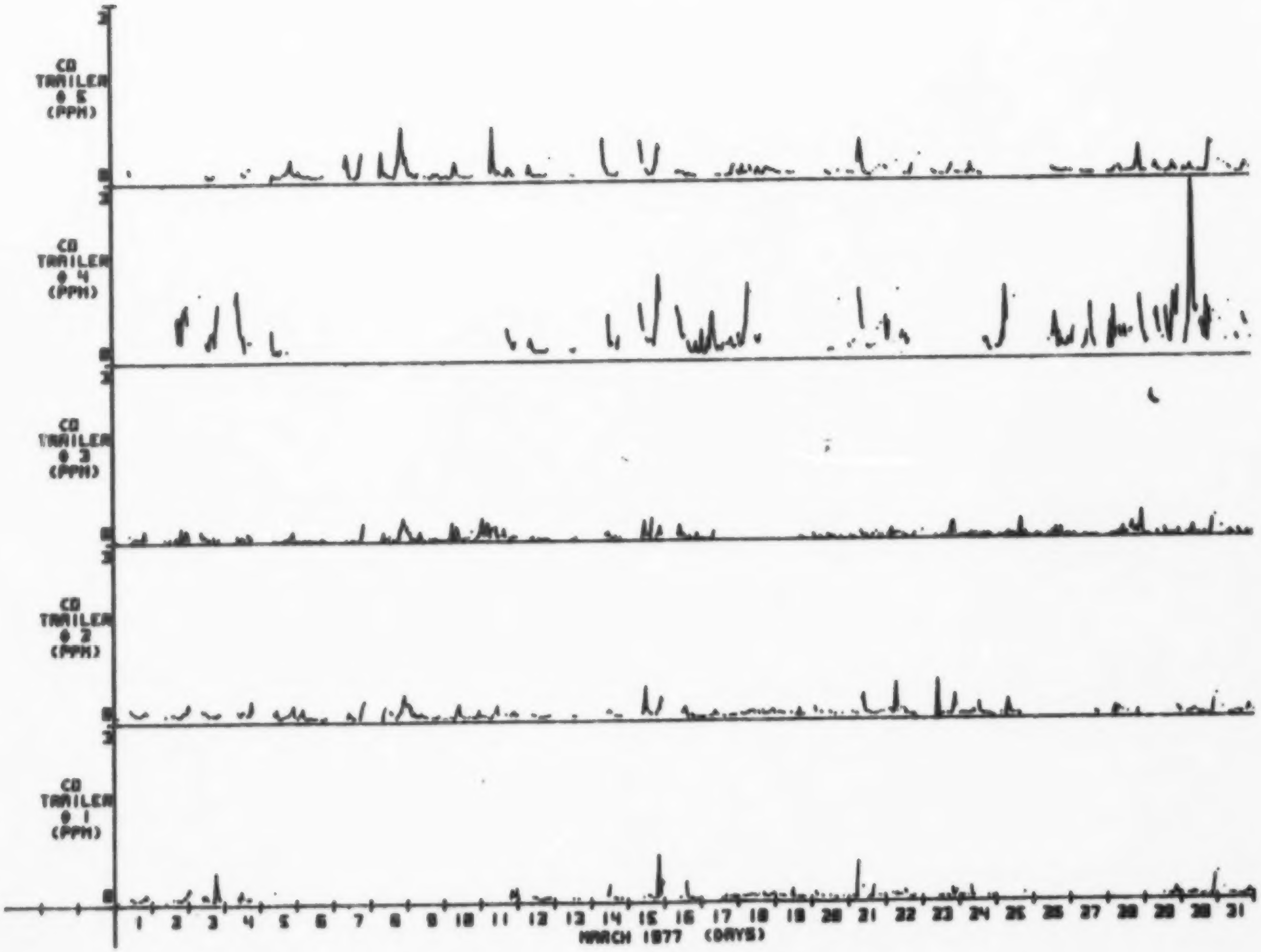

CO TRAILER # 5 (PPM)
CO TRAILER # 4 (PPM)
CO TRAILER # 3 (PPM)
CO TRAILER # 2 (PPM)
CO TRAILER # 1 (PPM)
2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MARCH 1977 (DAYS)

Figure H-64.

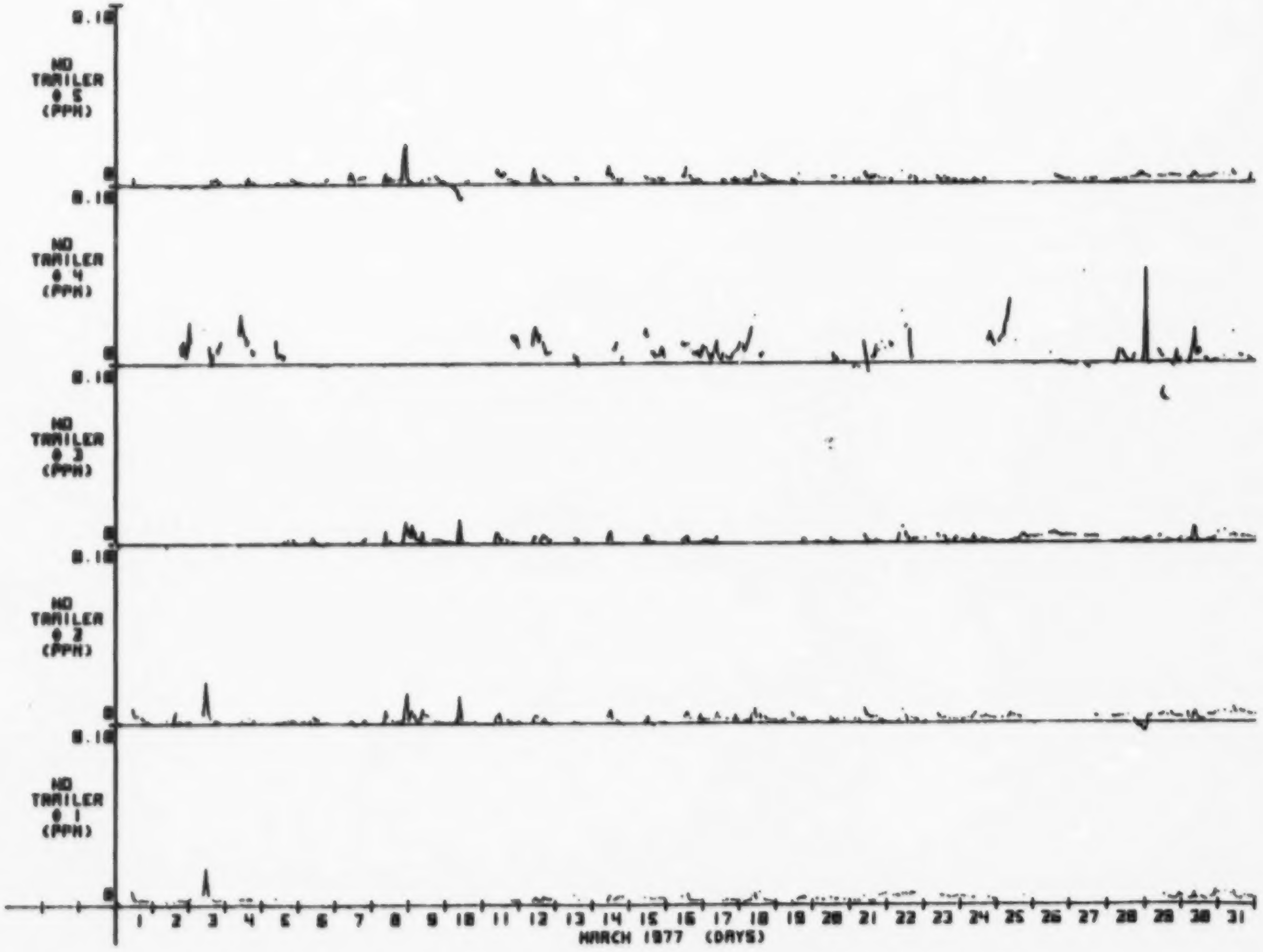

0.10
NO TRAILER 0.5 (PPM)
0
0.10
NO TRAILER 0.4 (PPM)
0
0.10
NO TRAILER 0.3 (PPM)
0
0.10
NO TRAILER 0.2 (PPM)
0
0.10
NO TRAILER 0.1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MARCH 1977 (DAYS)

Figure H-65.

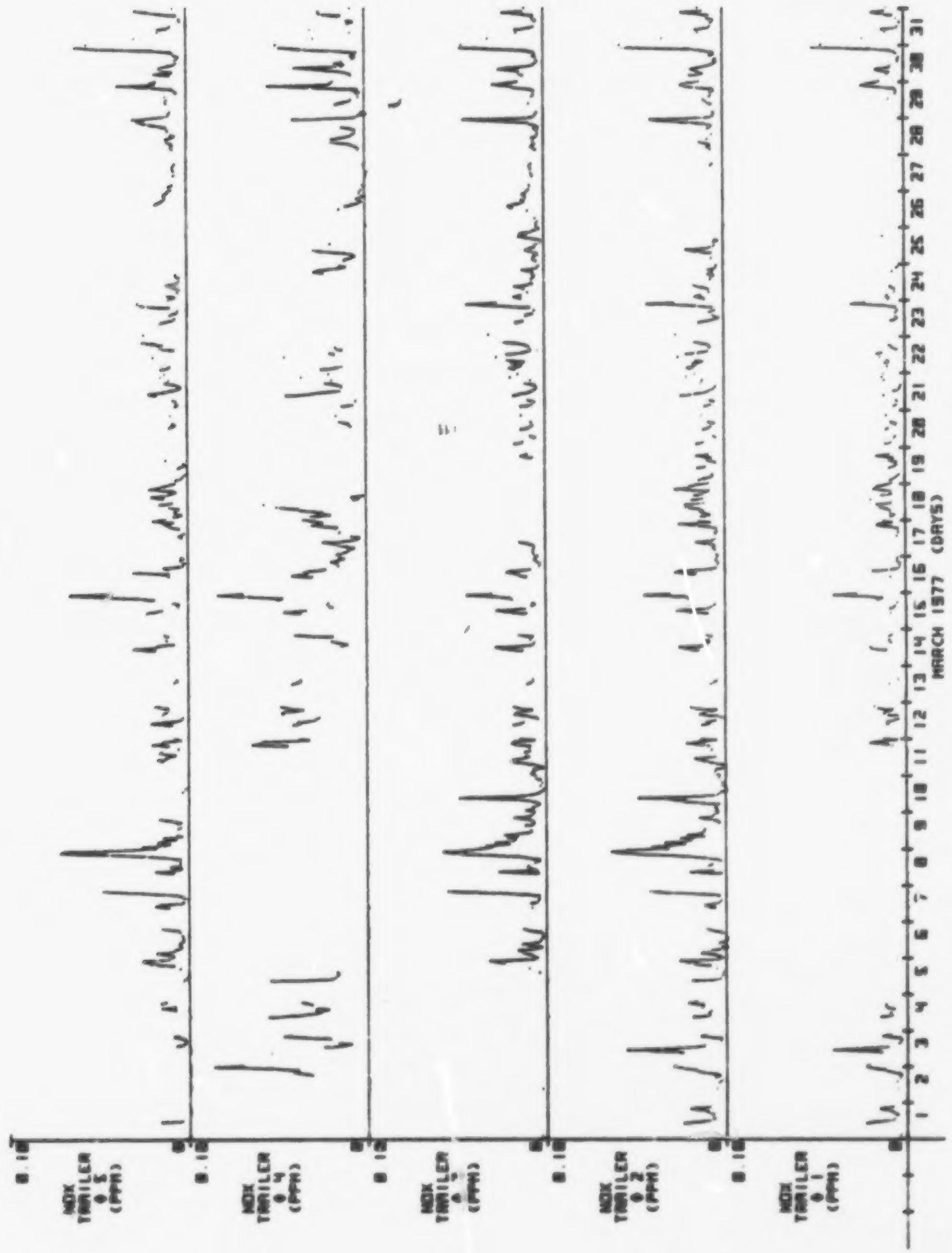

0.10
NOX TRAILER # 5 (PPM)
0
0.10
NOX TRAILER # 4 (PPM)
0
0.10
NOX TRAILER # 3 (PPM)
0
0.10
NOX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MARCH 1977 (DAYS)

Figure H-66.

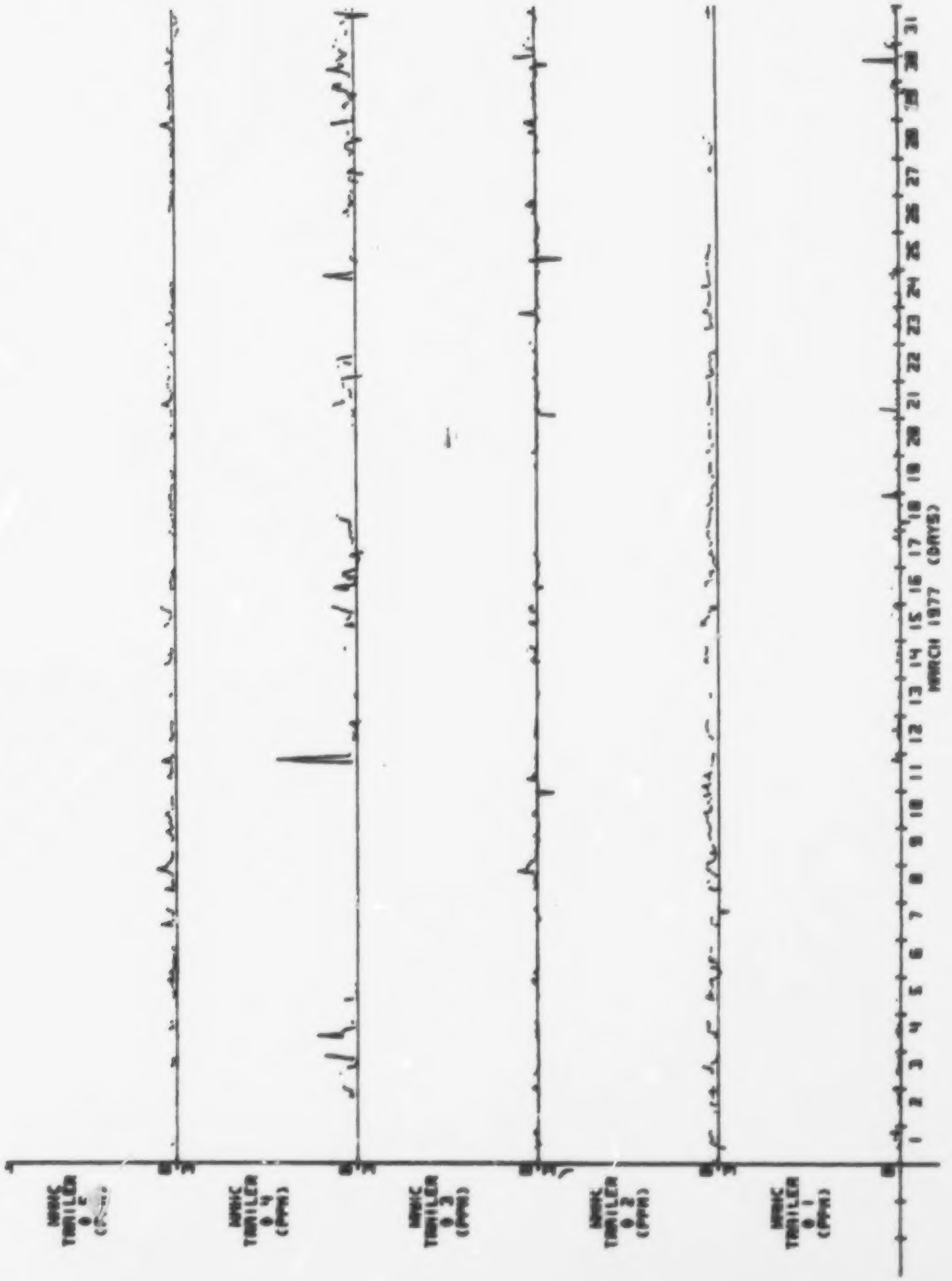

NMHC TRAILER 5 (PPM)
NMHC TRAILER 4 (PPM)
NMHC TRAILER 3 (PPM)
NMHC TRAILER 2 (PPM)
NMHC TRAILER 1 (PPM)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MARCH 1977 (DAYS)

Figure H-67.

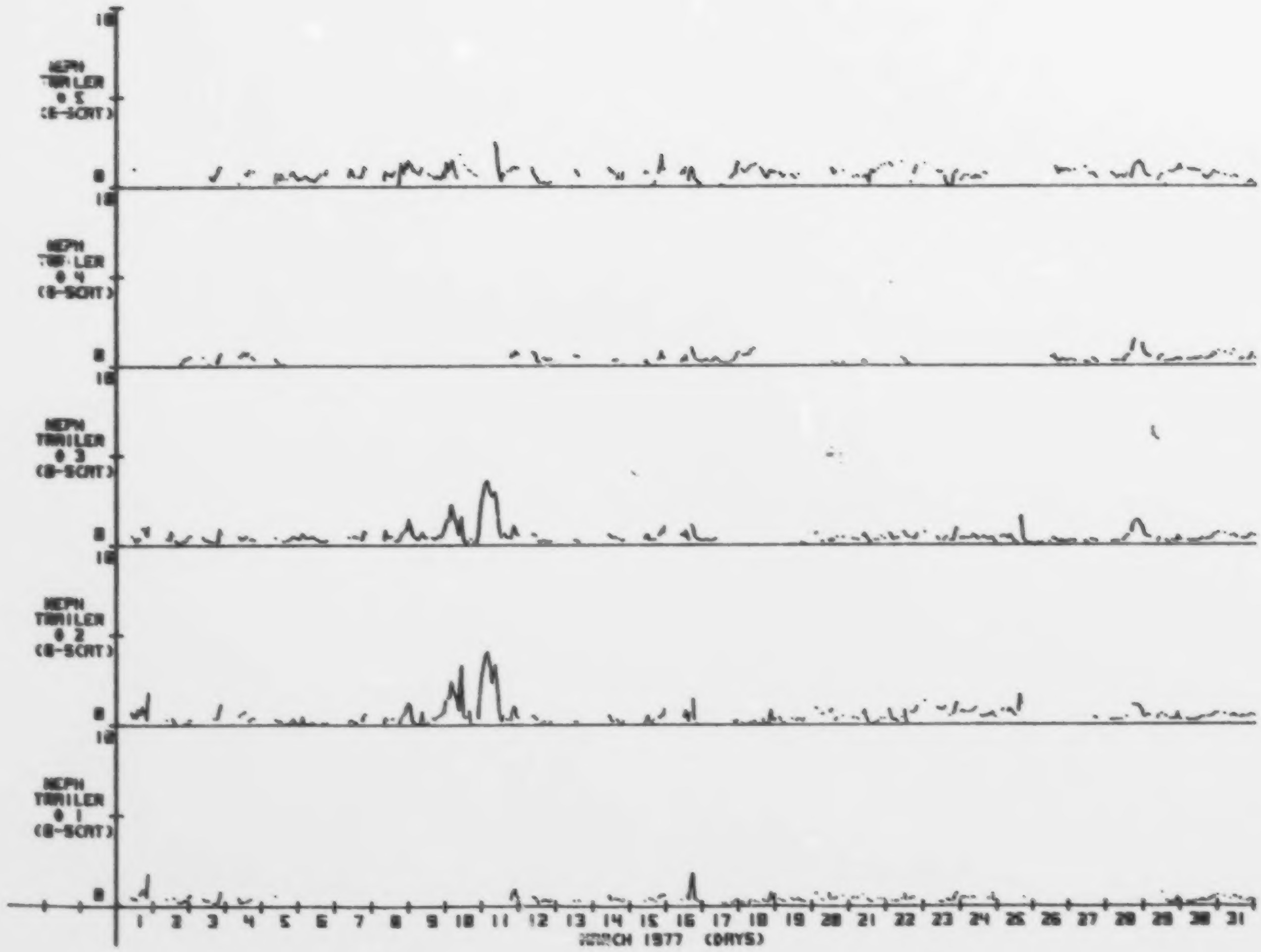

10
NEPH TRAILER # 5 (B-SCAT)
0
10
NEPH TRAILER # 4 (B-SCAT)
0
10
NEPH TRAILER # 3 (B-SCAT)
0
10
NEPH TRAILER # 2 (B-SCAT)
0
10
NEPH TRAILER # 1 (B-SCAT)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MARCH 1977 (DAYS)

Figure H-68.

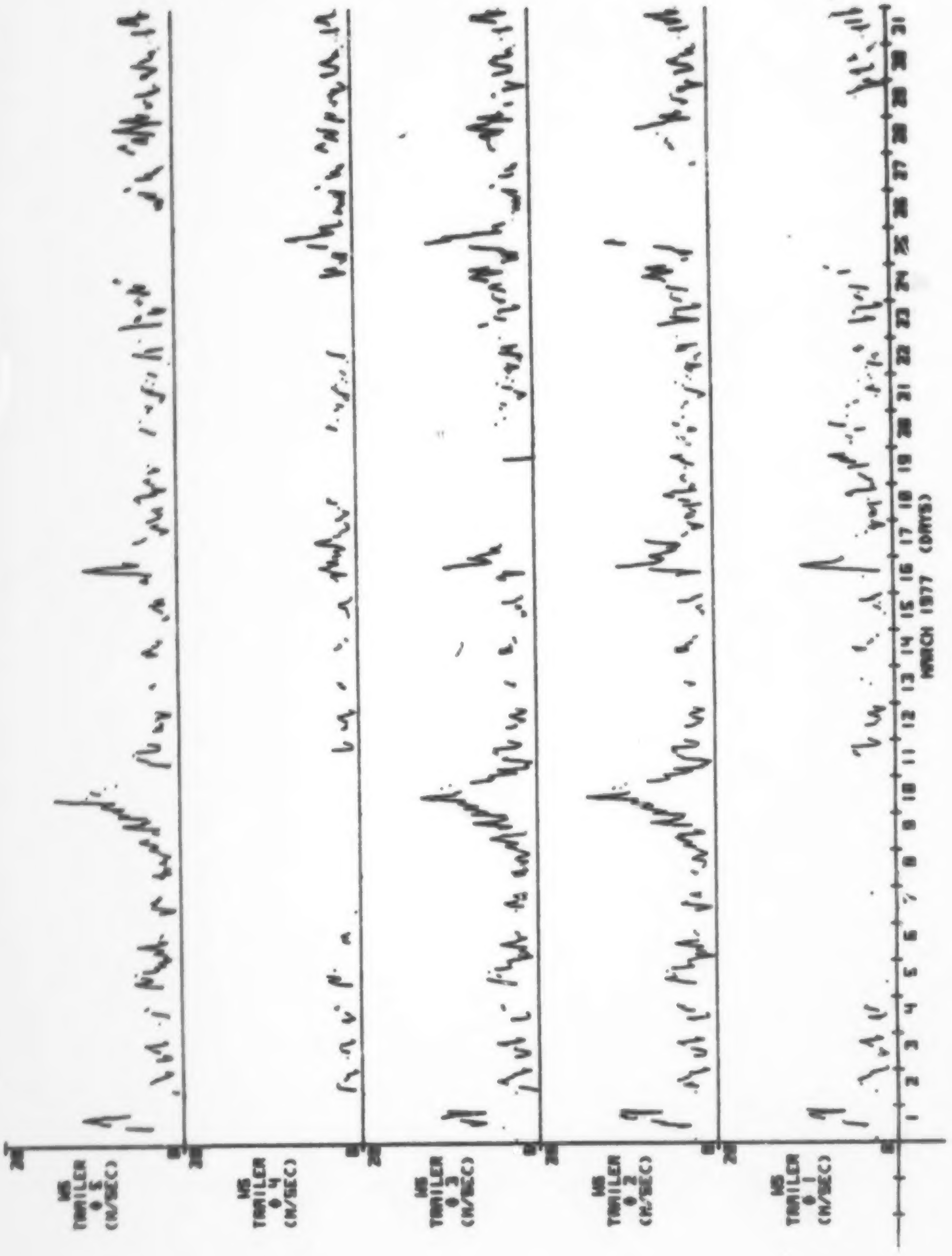

WS TRAILER # 5 (M/SEC)
WS TRAILER # 4 (M/SEC)
WS TRAILER # 3 (M/SEC)
WS TRAILER # 2 (M/SEC)
WS TRAILER # 1 (M/SEC)
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MARCH 1977 (DAYS)

Figure H-69.

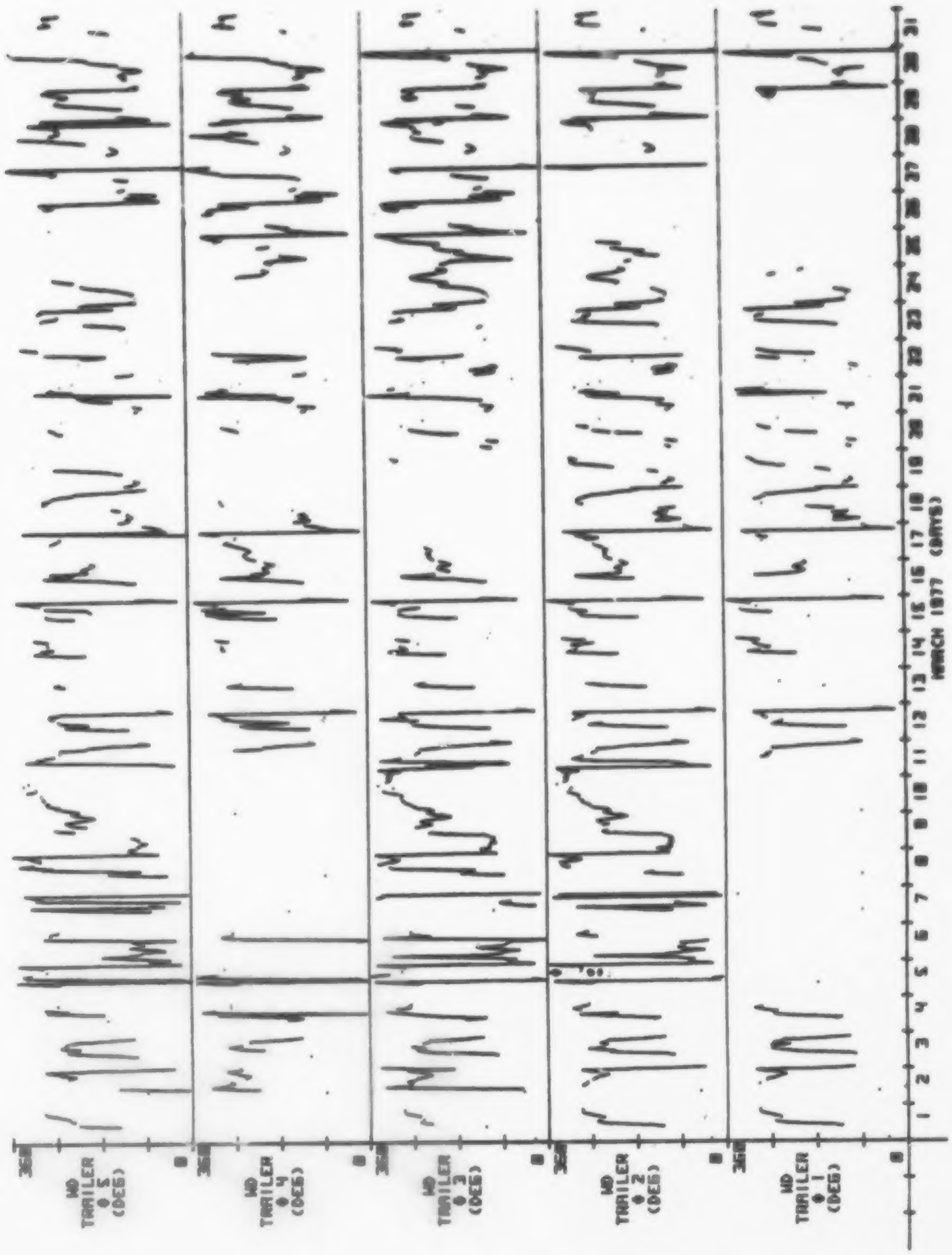

WD TRAILER # 5 (DEG)
WD TRAILER # 4 (DEG)
WD TRAILER # 3 (DEG)
WD TRAILER # 2 (DEG)
WD TRAILER # 1 (DEG)
360
0
MARCH 1977 (DAYS)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31

Figure H-70

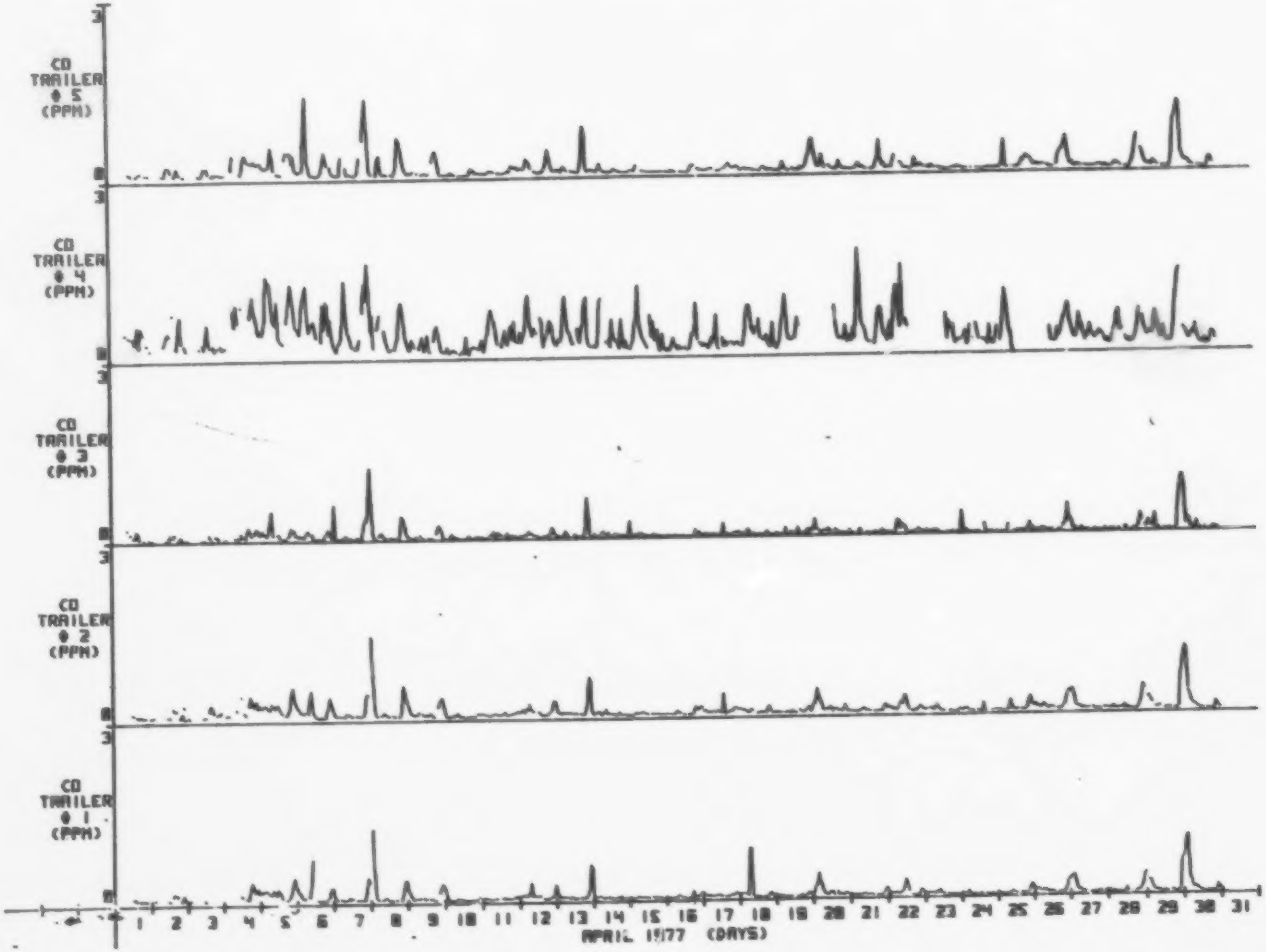

3
CO
TRAILER
# 5
(PPM)
0
3
CO
TRAILER
# 4
(PPM)
0
3
CO
TRAILER
# 3
(PPM)
0
3
CO
TRAILER
# 2
(PPM)
0
3
CO
TRAILER
# 1
(PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
APRIL 1977 (DAYS)

Figure H-71.

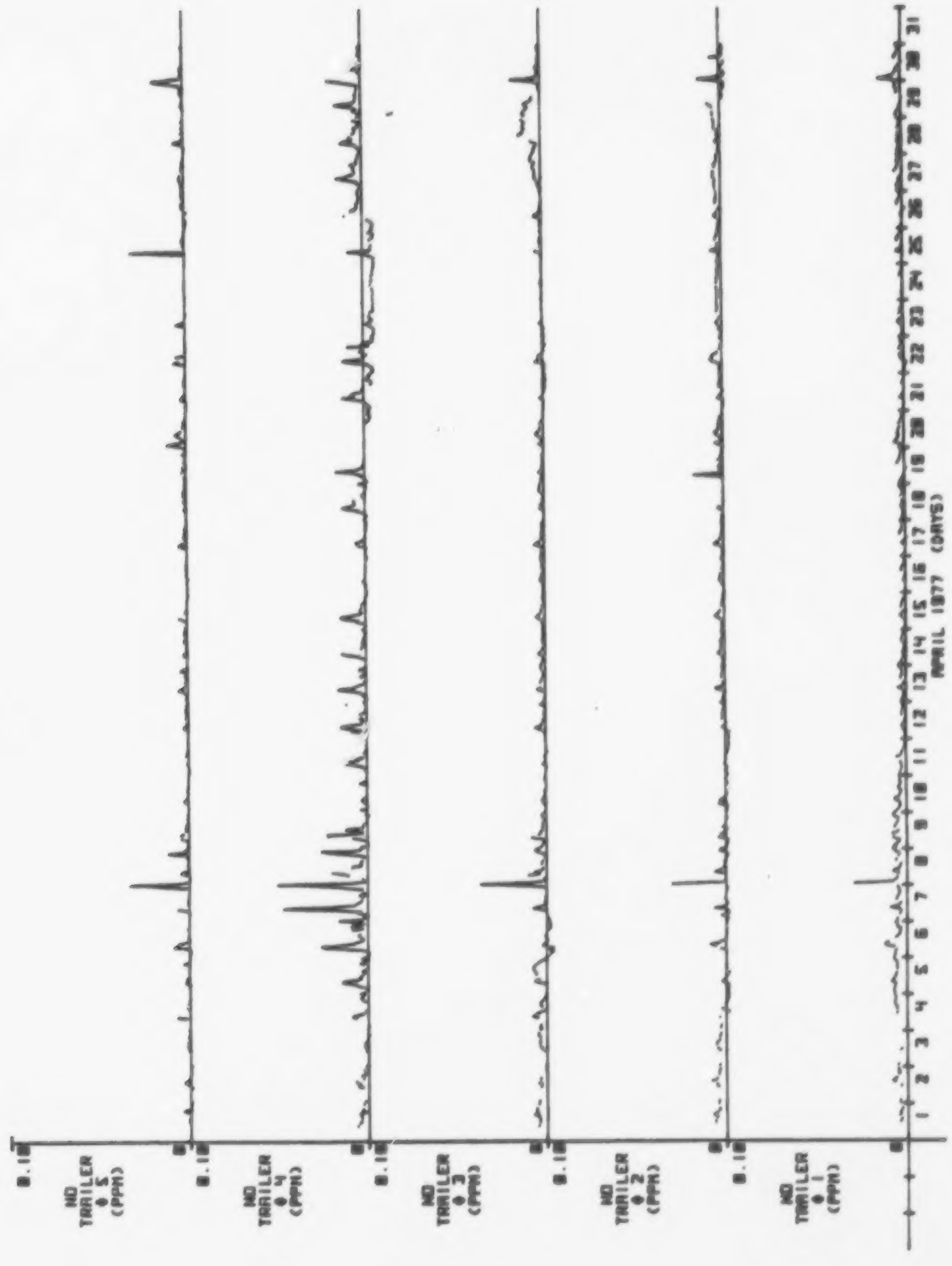

0.10
NO TRAILER # 5 (PPM)
0
0.10
NO TRAILER # 4 (PPM)
0
0.10
NO TRAILER # 3 (PPM)
0
0.10
NO TRAILER # 2 (PPM)
0
0.10
NO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
APRIL 1977 (DAYS)

Figure H-72.

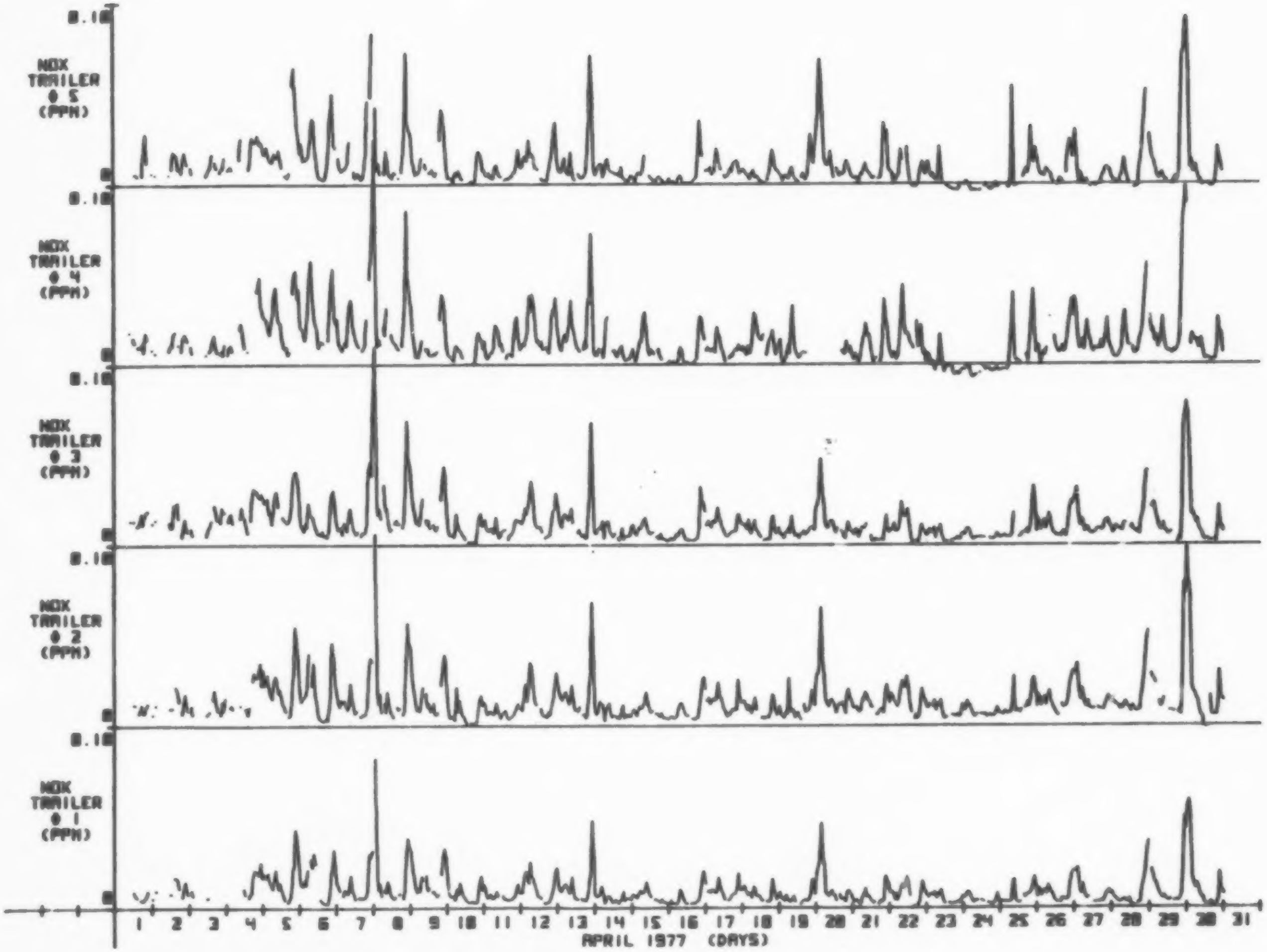

0.10
NOX TRAILER # 5 (PPM)
0
0.10
NOX TRAILER # 4 (PPM)
0
0.10
NOX TRAILER # 3 (PPM)
0
0.10
NOX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
APRIL 1977 (DAYS)

Figure H-73.

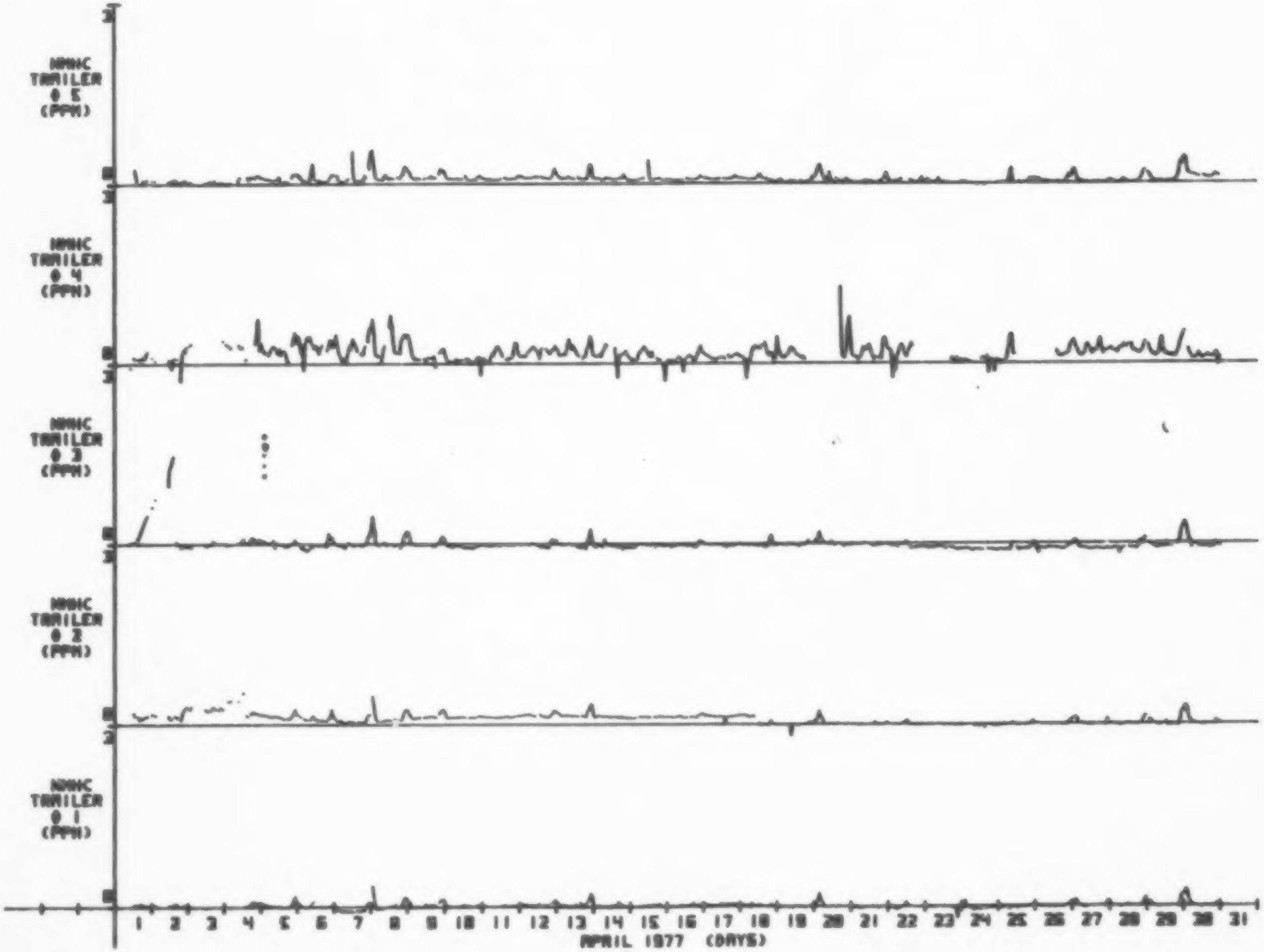

NMHC TRAILER @ 5 (PPM)
NMHC TRAILER @ 4 (PPM)
NMHC TRAILER @ 3 (PPM)
NMHC TRAILER @ 2 (PPM)
NMHC TRAILER @ 1 (PPM)
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
APRIL 1977 (DAYS)

Figure H-74.

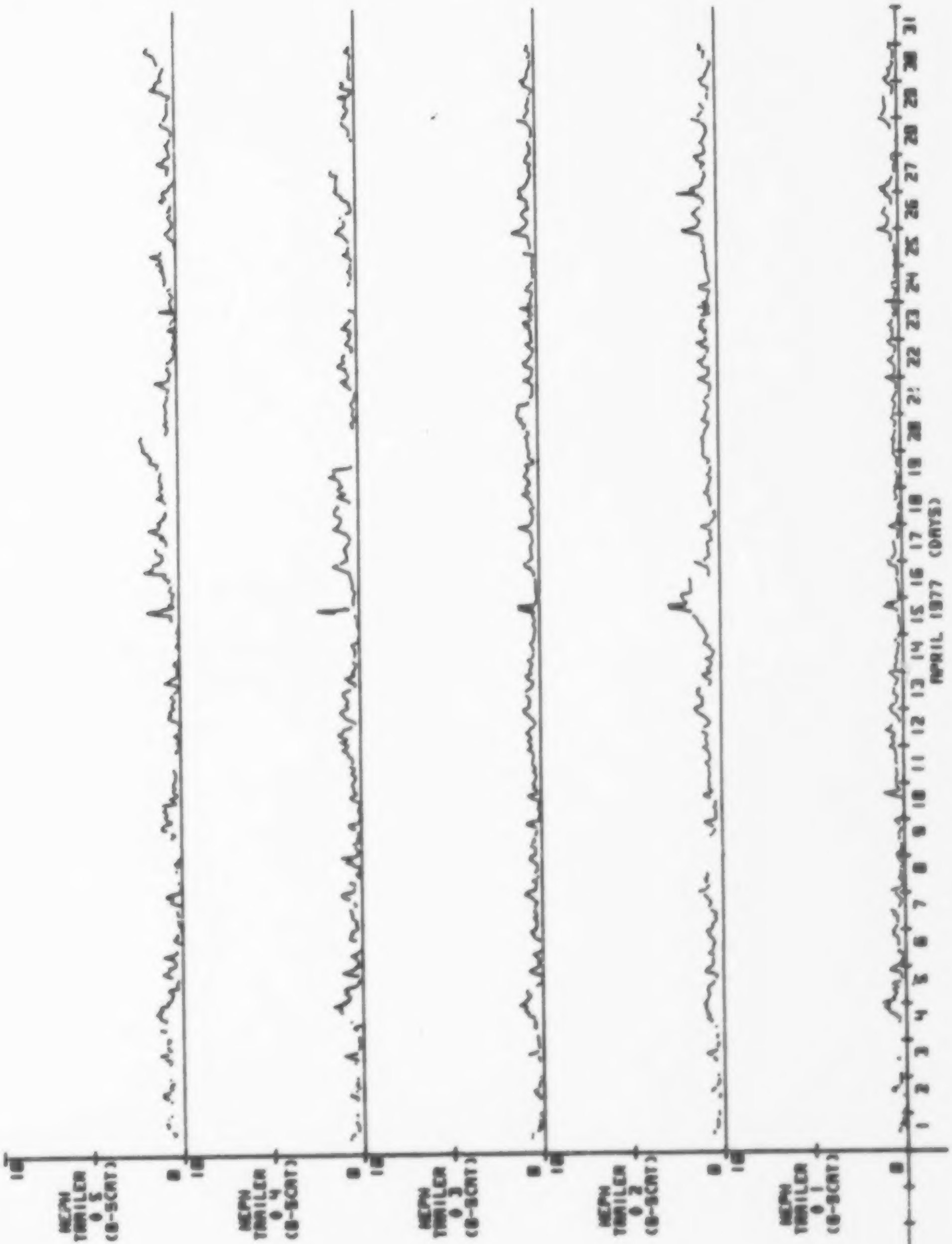

NEPH TRAILER 0.5 (B-SCAT)
NEPH TRAILER 0.4 (B-SCAT)
NEPH TRAILER 0.3 (B-SCAT)
NEPH TRAILER 0.2 (B-SCAT)
NEPH TRAILER 0.1 (B-SCAT)
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
APRIL 1977 (DAYS)

Figure H-75.

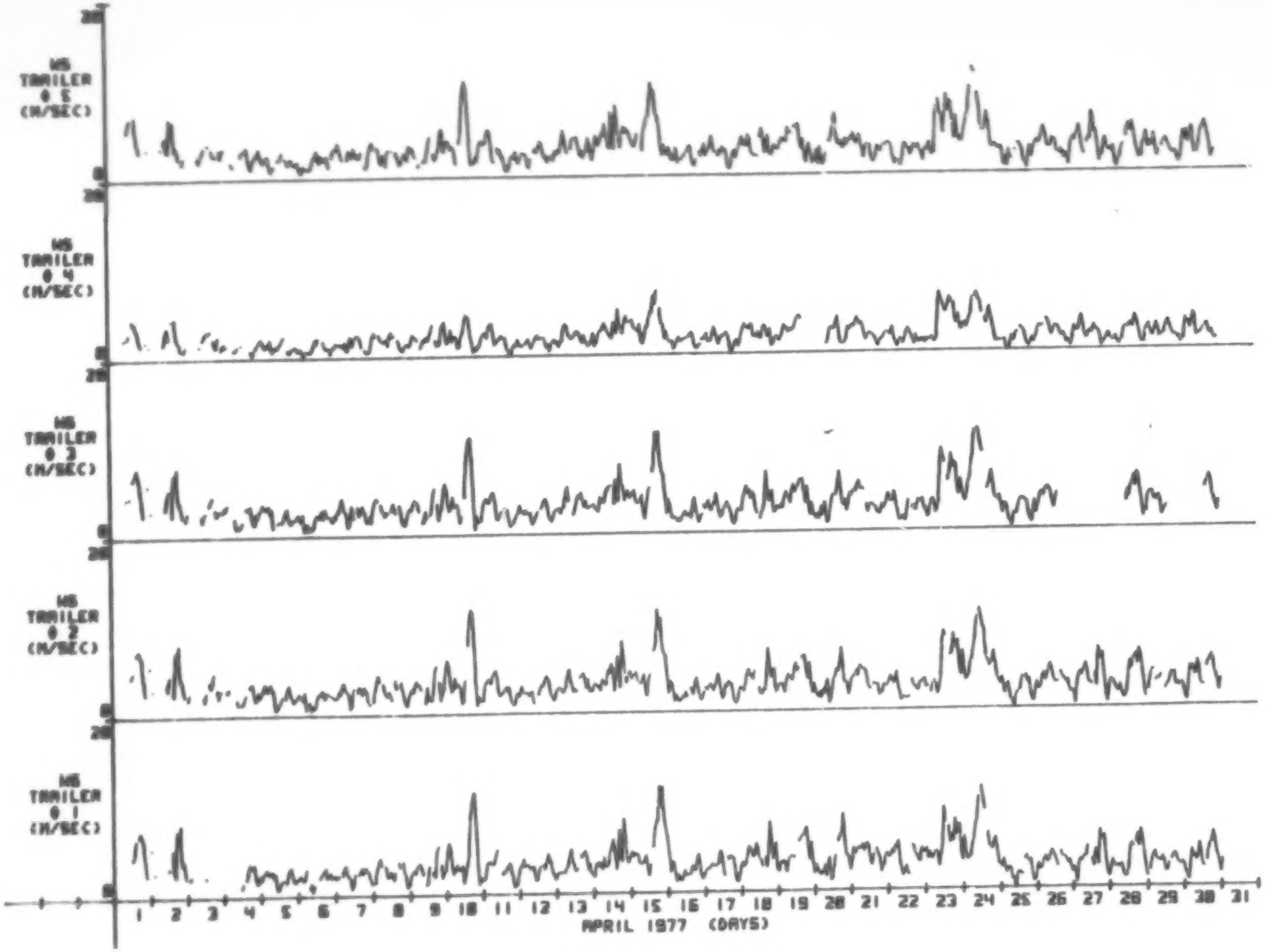

20
WS TRAILER @ 5 (M/SEC)
0
20
WS TRAILER @ 4 (M/SEC)
0
20
WS TRAILER @ 3 (M/SEC)
0
20
WS TRAILER @ 2 (M/SEC)
0
20
WS TRAILER @ 1 (M/SEC)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
APRIL 1977 (DAYS)

Figure H-76.

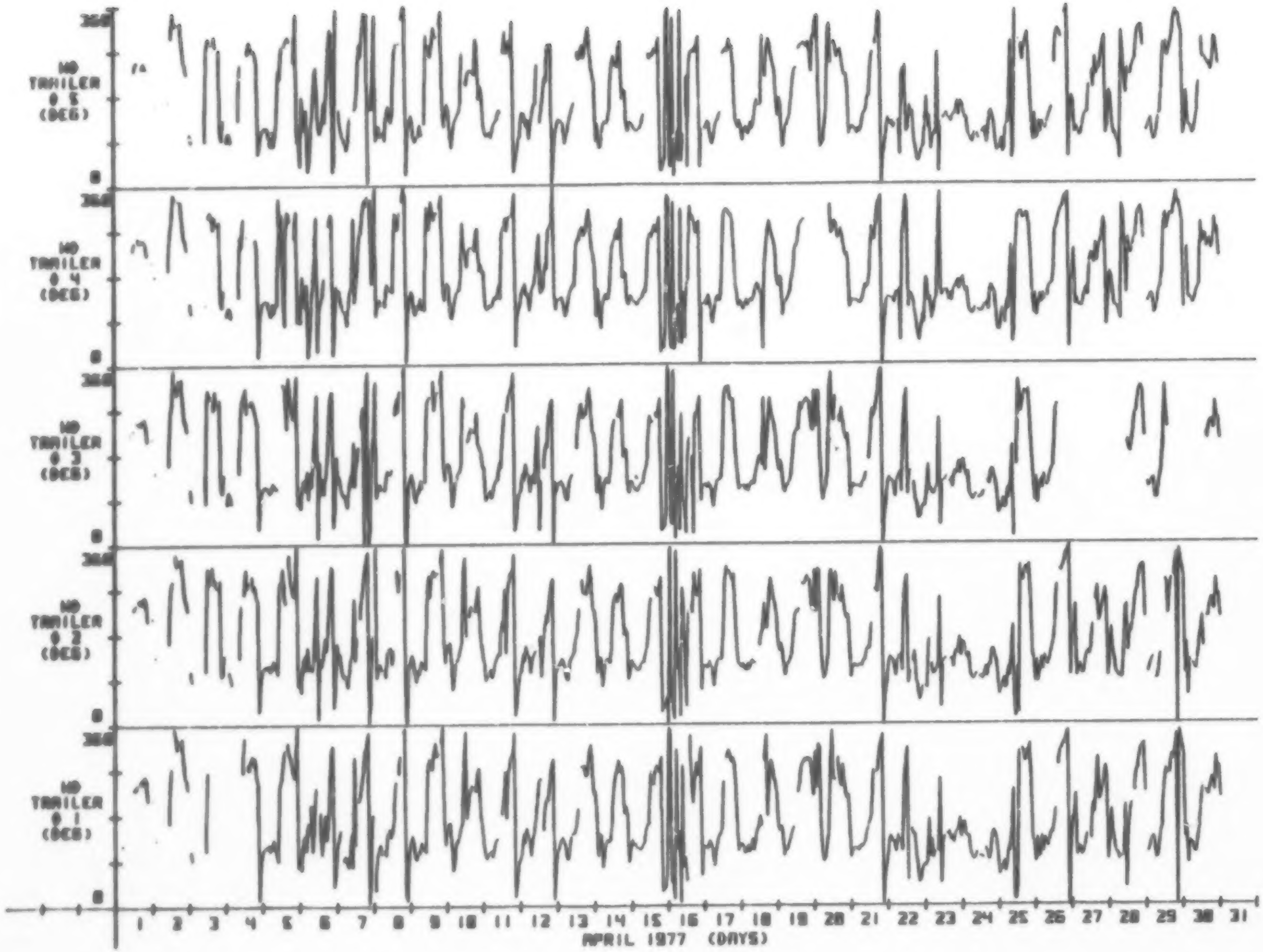

360
WD
TRAILER
@ 5
(DEG)
0
360
WD
TRAILER
@ 4
(DEG)
0
360
WD
TRAILER
@ 3
(DEG)
0
360
WD
TRAILER
@ 2
(DEG)
0
360
WD
TRAILER
@ 1
(DEG)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
APRIL 1977 (DAYS)

Figure H-77.

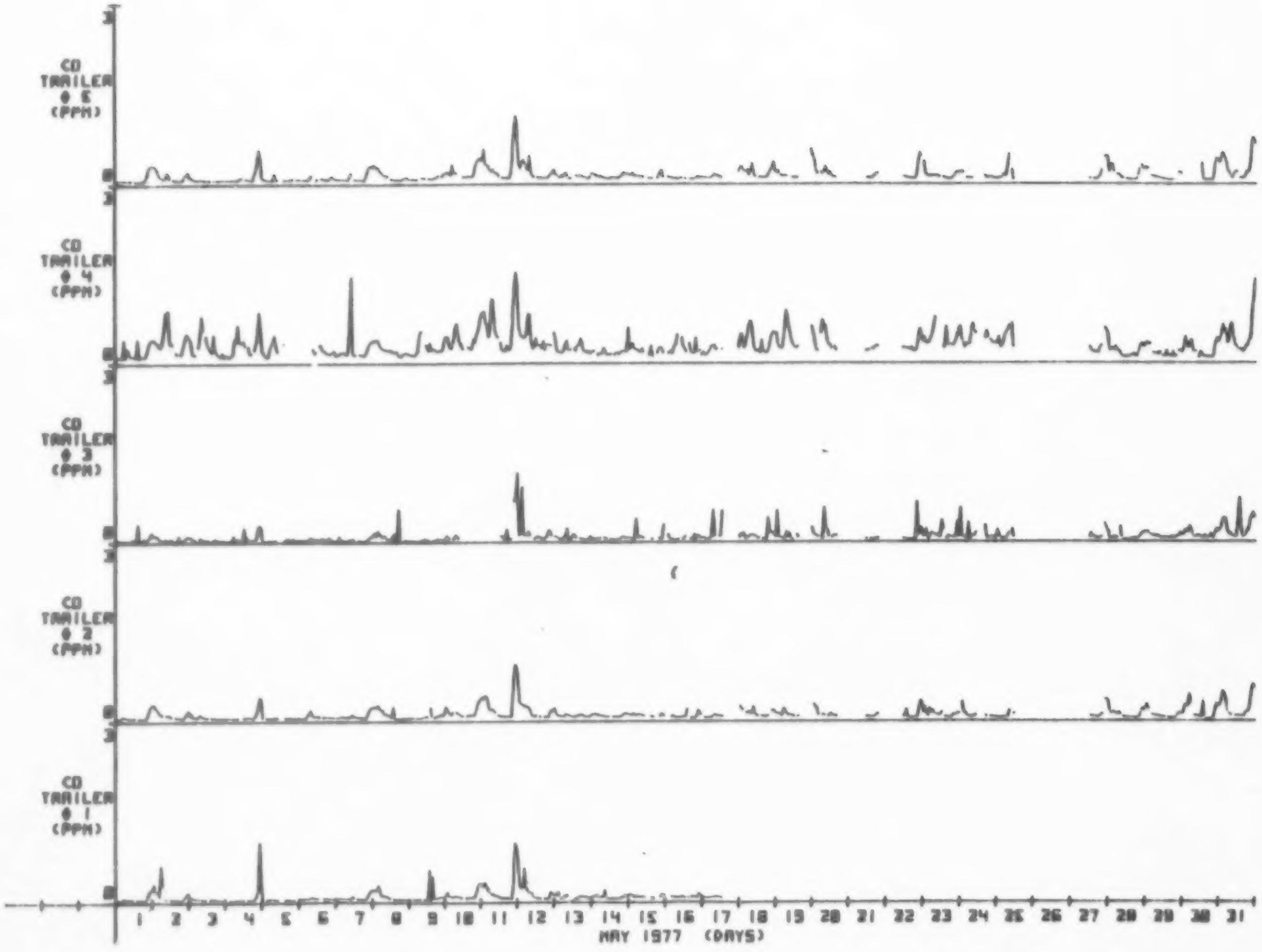

CO TRAILER # 6 (PPM)
CO TRAILER # 4 (PPM)
CO TRAILER # 3 (PPM)
CO TRAILER # 2 (PPM)
CO TRAILER # 1 (PPM)
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY 1977 (DAYS)

Figure H-78.

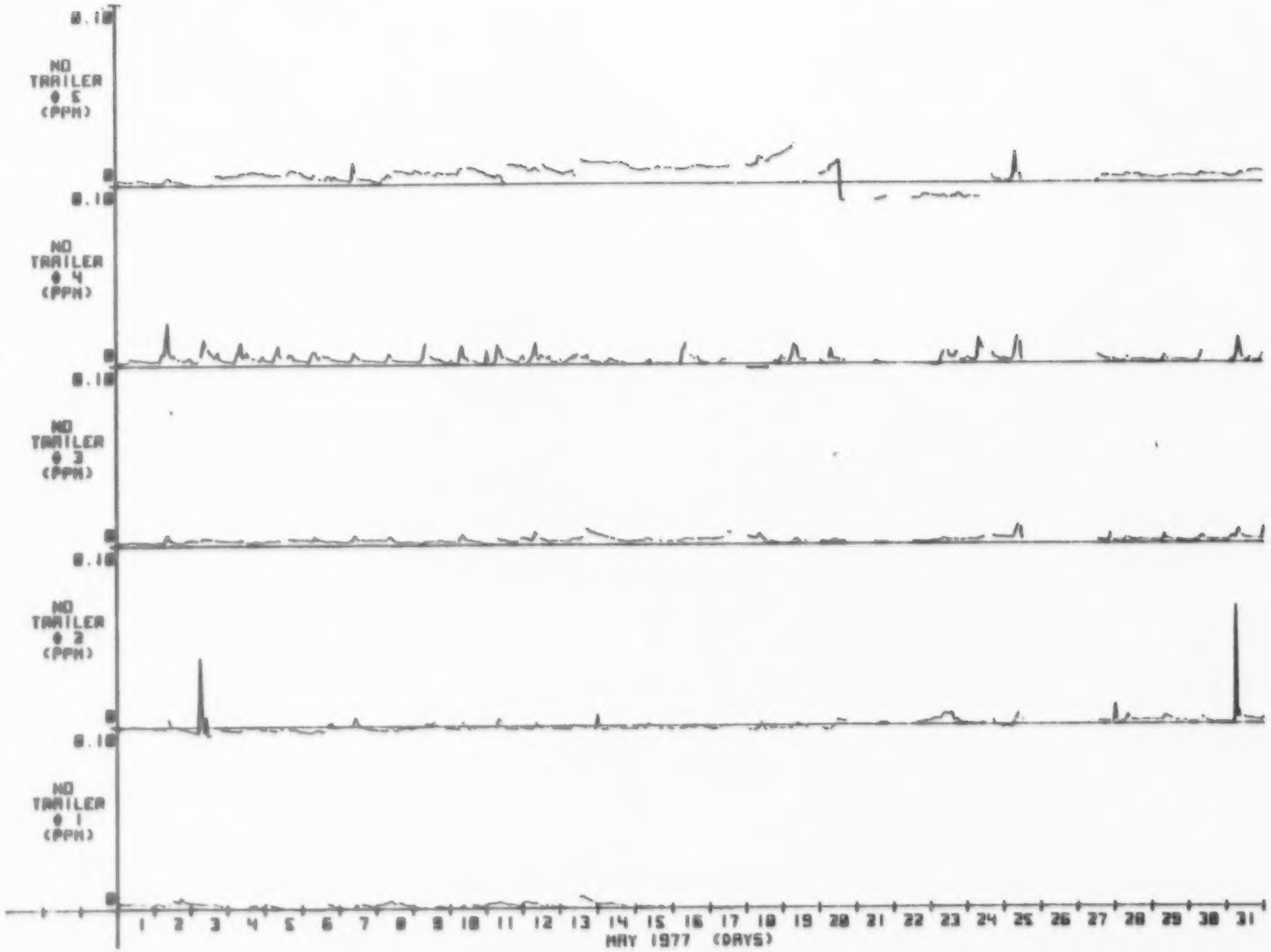

0.10
NO TRAILER # 5 (PPM)
0
0.10
NO TRAILER # 4 (PPM)
0
0.10
NO TRAILER # 3 (PPM)
0
0.10
NO TRAILER # 2 (PPM)
0
0.10
NO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY 1977 (DAYS)

Figure H-79.

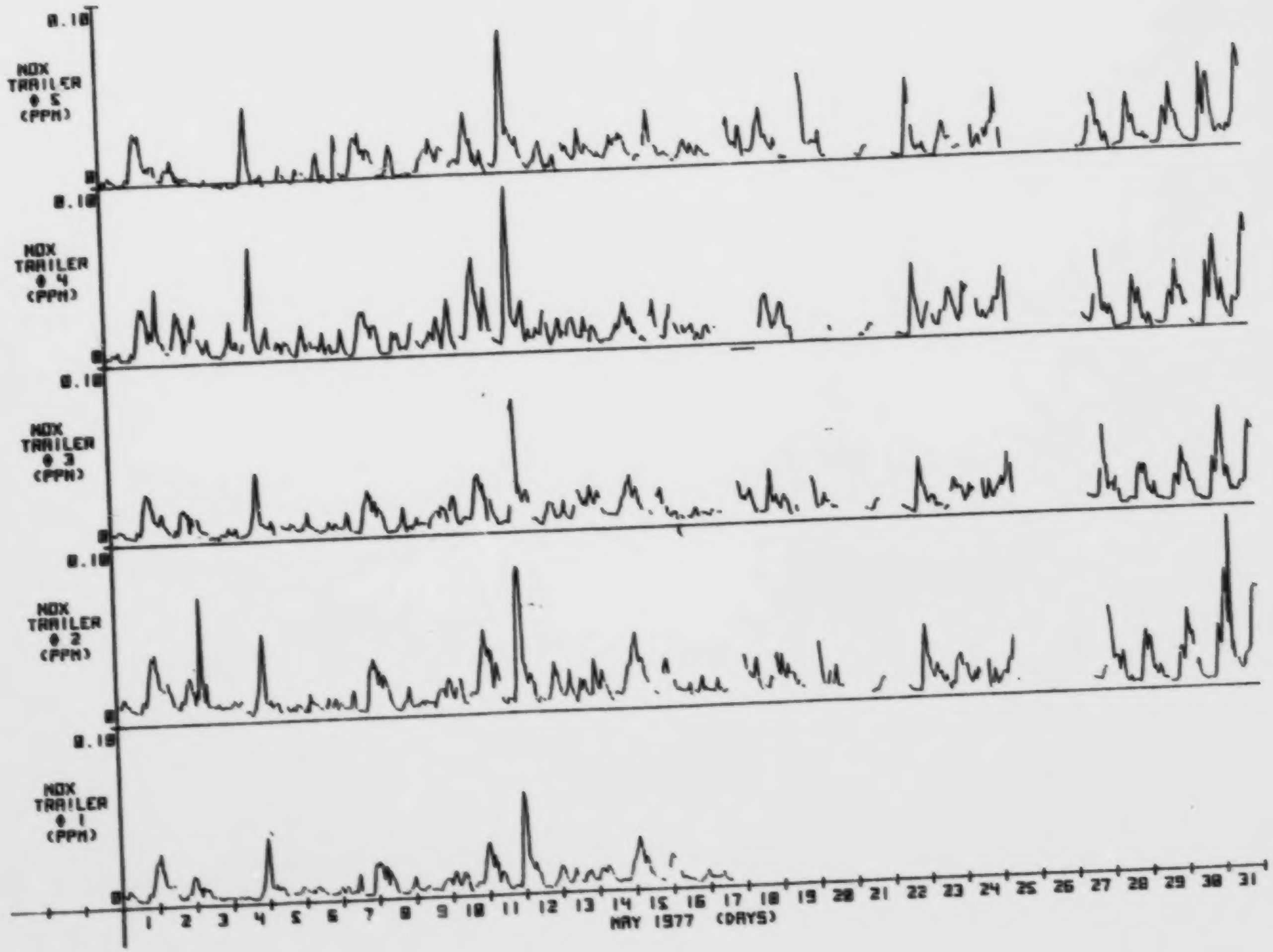

0.10
NOX
TRAILER
# 5
(PPM)
0
0.10
NOX
TRAILER
# 4
(PPM)
0
0.10
NOX
TRAILER
# 3
(PPM)
0
0.10
NOX
TRAILER
# 2
(PPM)
0
0.10
NOX
TRAILER
# 1
(PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY 1977 (DAYS)

Figure H-80.

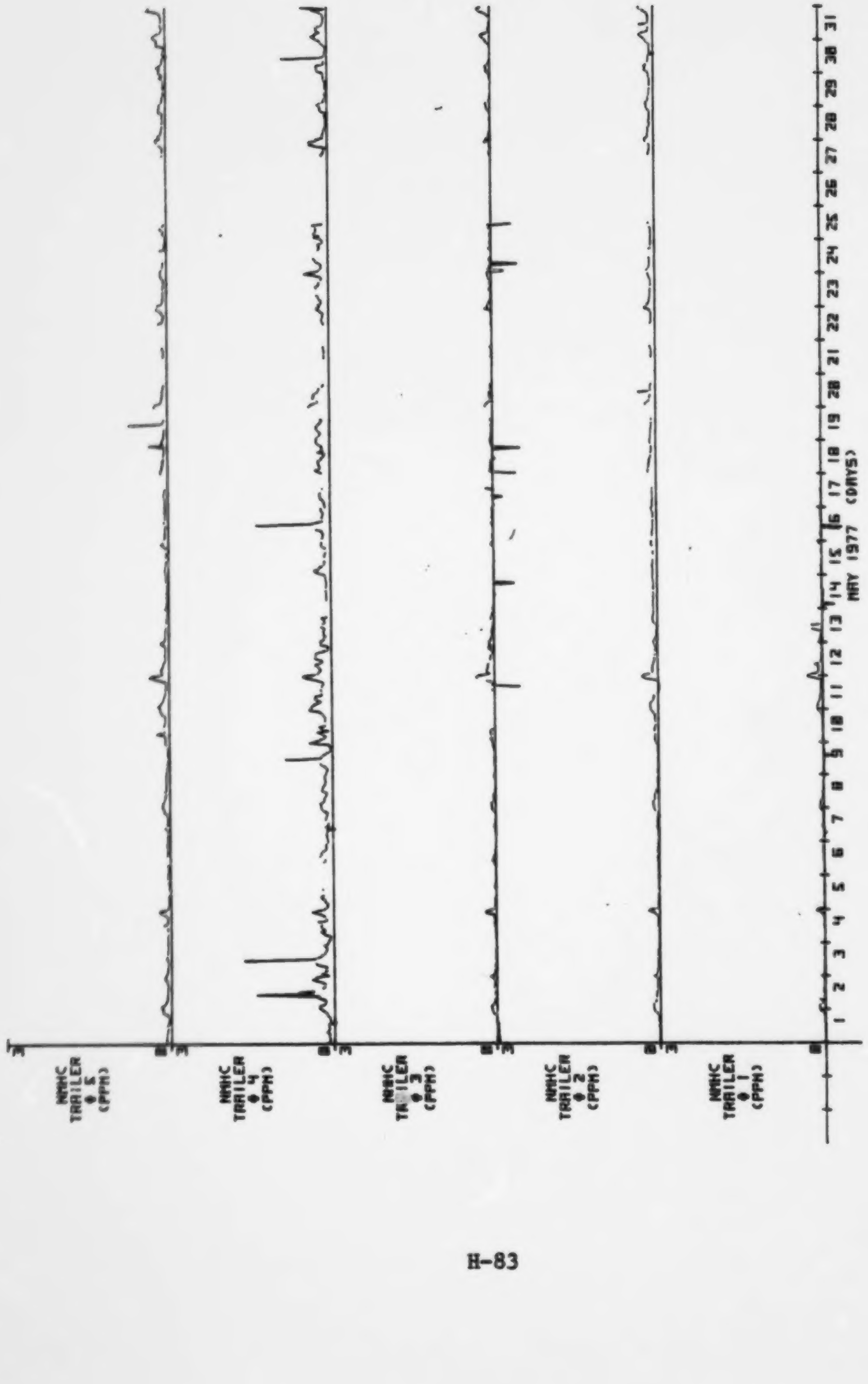
NMHC TRAILER # 5 (PPM)
NMHC TRAILER # 4 (PPM)
NMHC TRAILER # 3 (PPM)
NMHC TRAILER # 2 (PPM)
NMHC TRAILER # 1 (PPM)
0
3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY 1977 (DAYS)

Figure H-81.

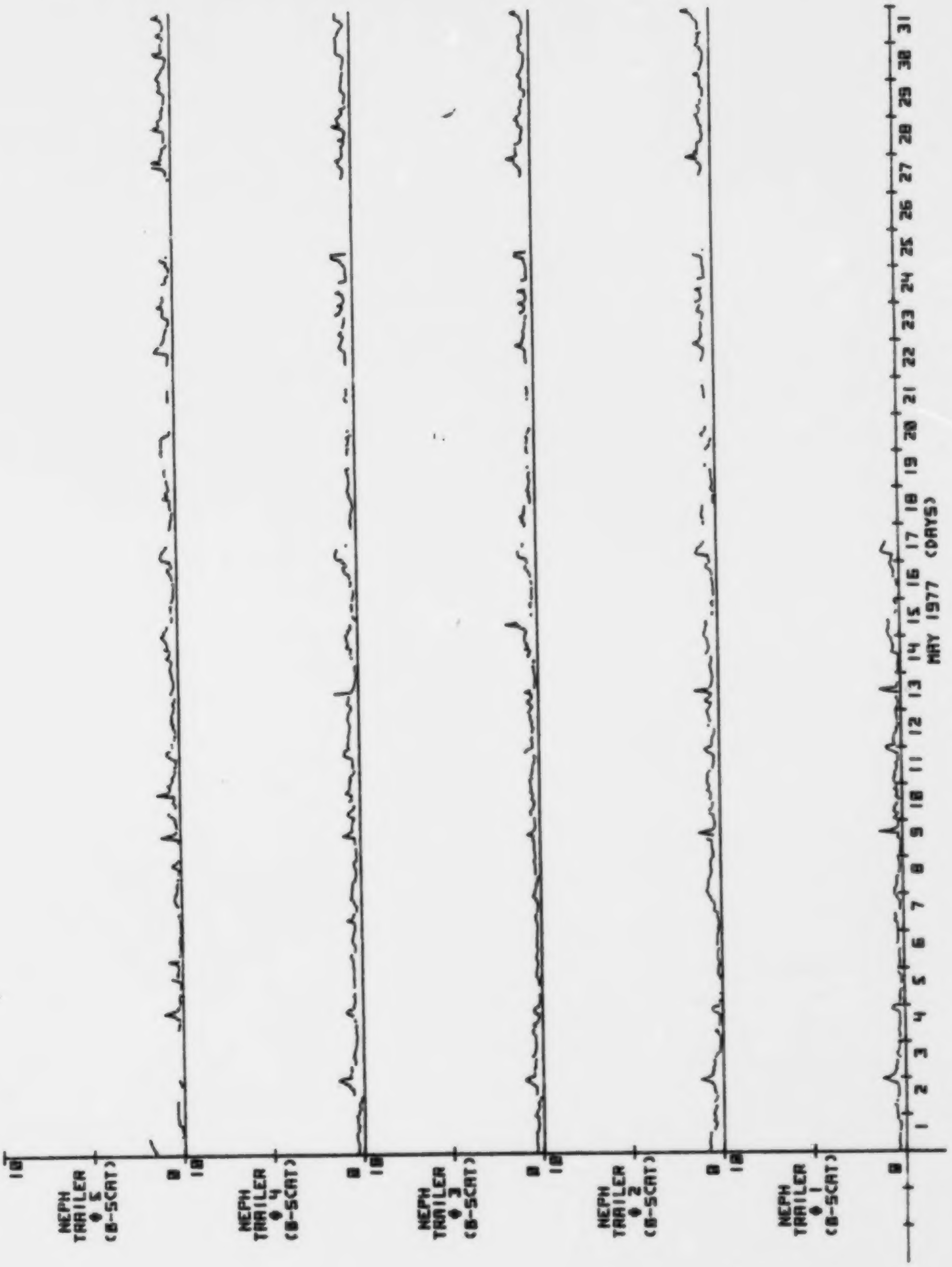

NEPH TRAILER # 5 (B-SCAT)
NEPH TRAILER # 4 (B-SCAT)
NEPH TRAILER # 3 (B-SCAT)
NEPH TRAILER # 2 (B-SCAT)
NEPH TRAILER # 1 (B-SCAT)
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY 1977 (DAYS)

Figure H-82.

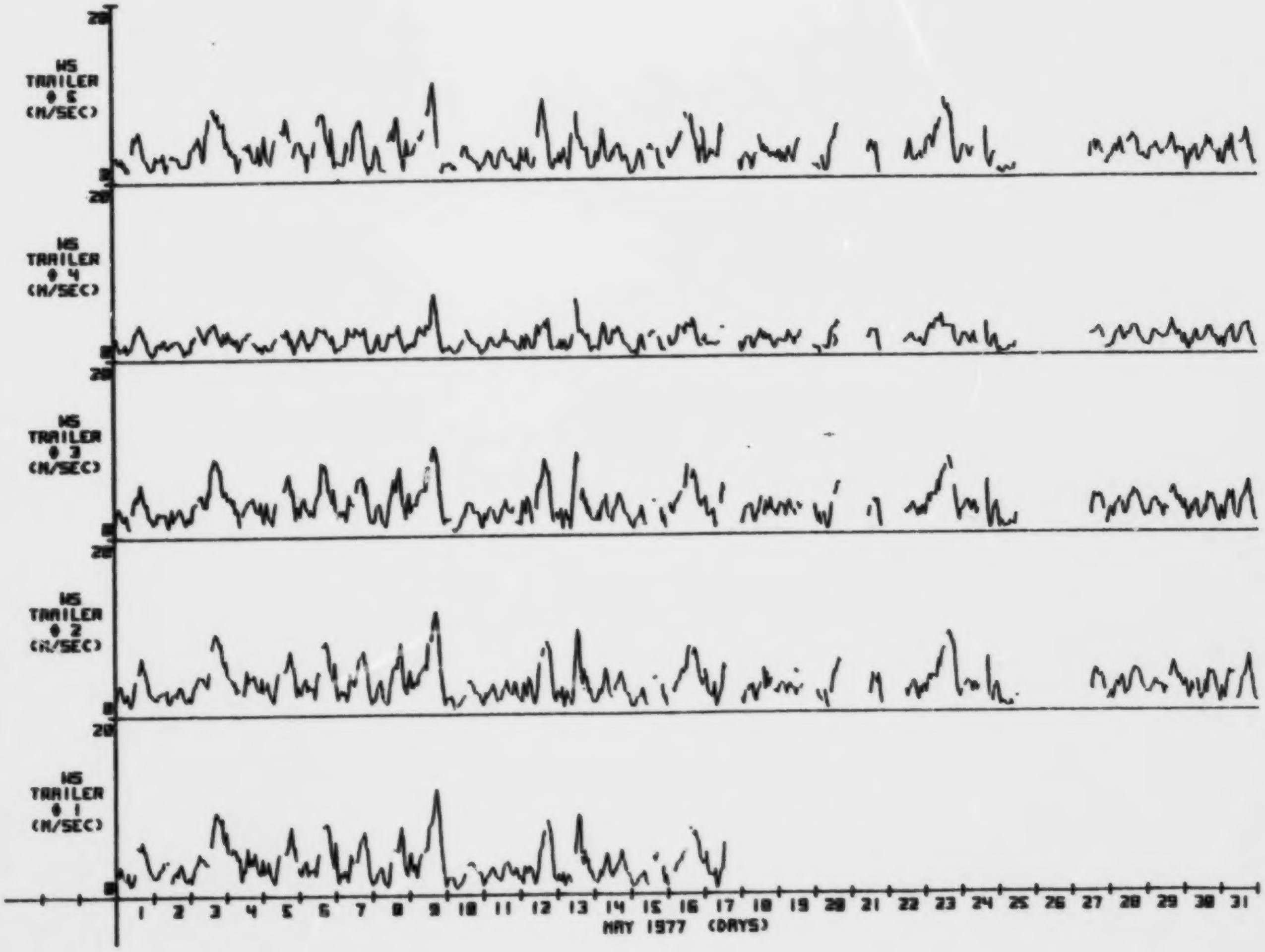

20
WS TRAILER # 5 (M/SEC)
0
20
WS TRAILER # 4 (M/SEC)
0
20
WS TRAILER # 3 (M/SEC)
0
20
WS TRAILER # 2 (M/SEC)
0
20
WS TRAILER # 1 (M/SEC)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY 1977 (DAYS)

Figure H-83.

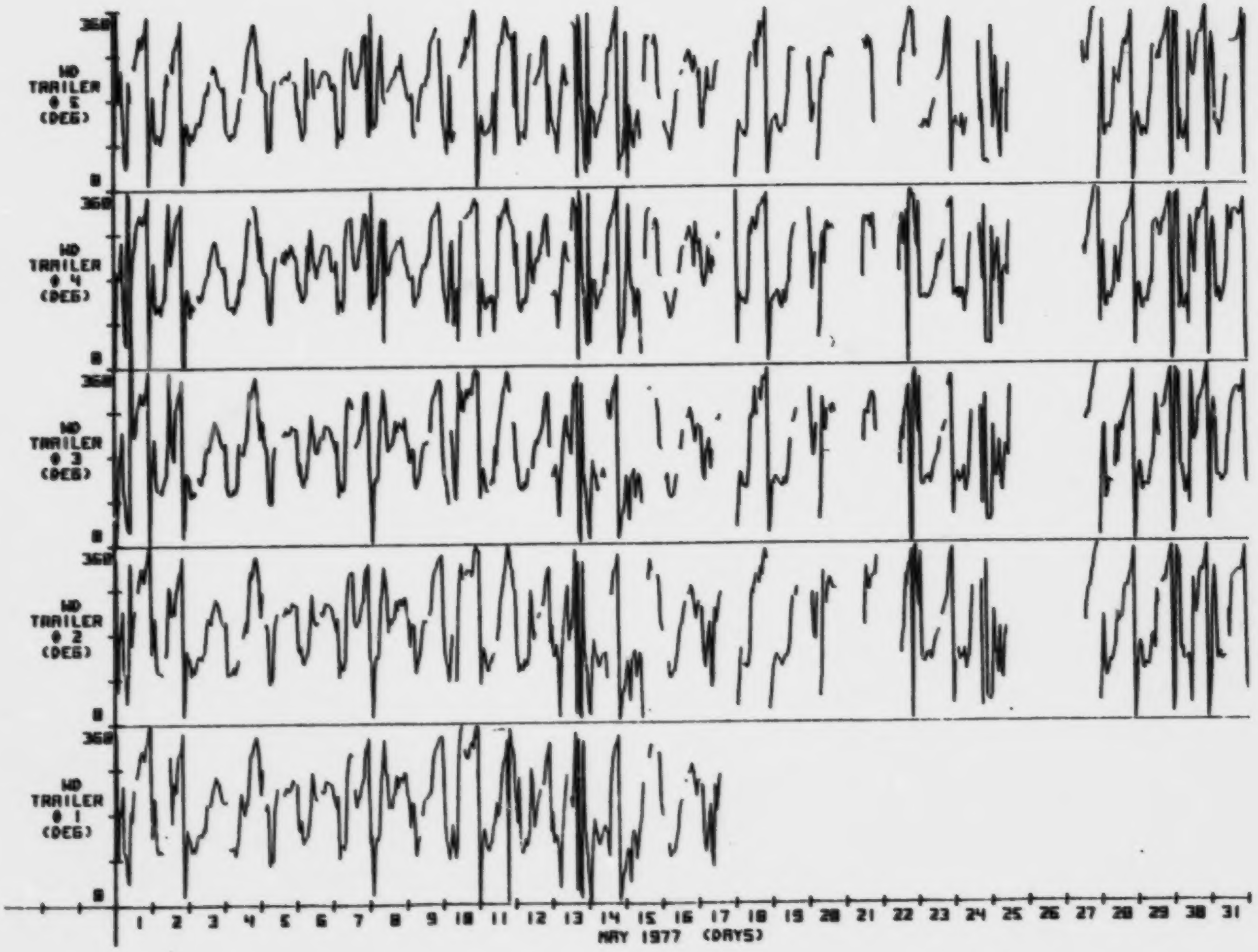
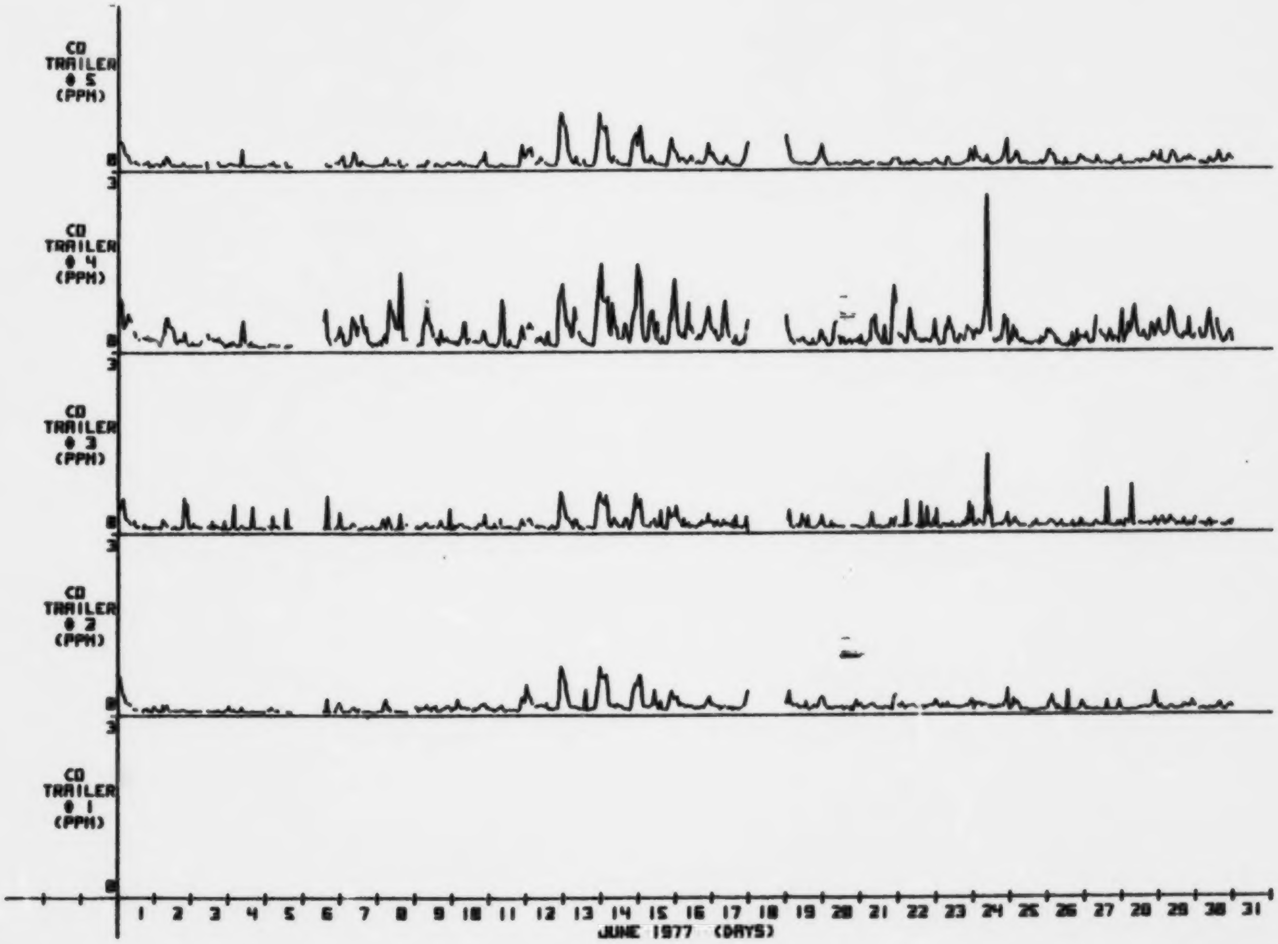

360
WD TRAILER # 5 (DEG)
0
360
WD TRAILER # 4 (DEG)
0
360
WD TRAILER # 3 (DEG)
0
360
WD TRAILER # 2 (DEG)
0
360
WD TRAILER # 1 (DEG)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY 1977 (DAYS)

Figure H-84.



CO TRAILER # 5 (PPM)
CO TRAILER # 4 (PPM)
CO TRAILER # 3 (PPM)
CO TRAILER # 2 (PPM)
CO TRAILER # 1 (PPM)
0
3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JUNE 1977 (DAYS)

Figure H-85.

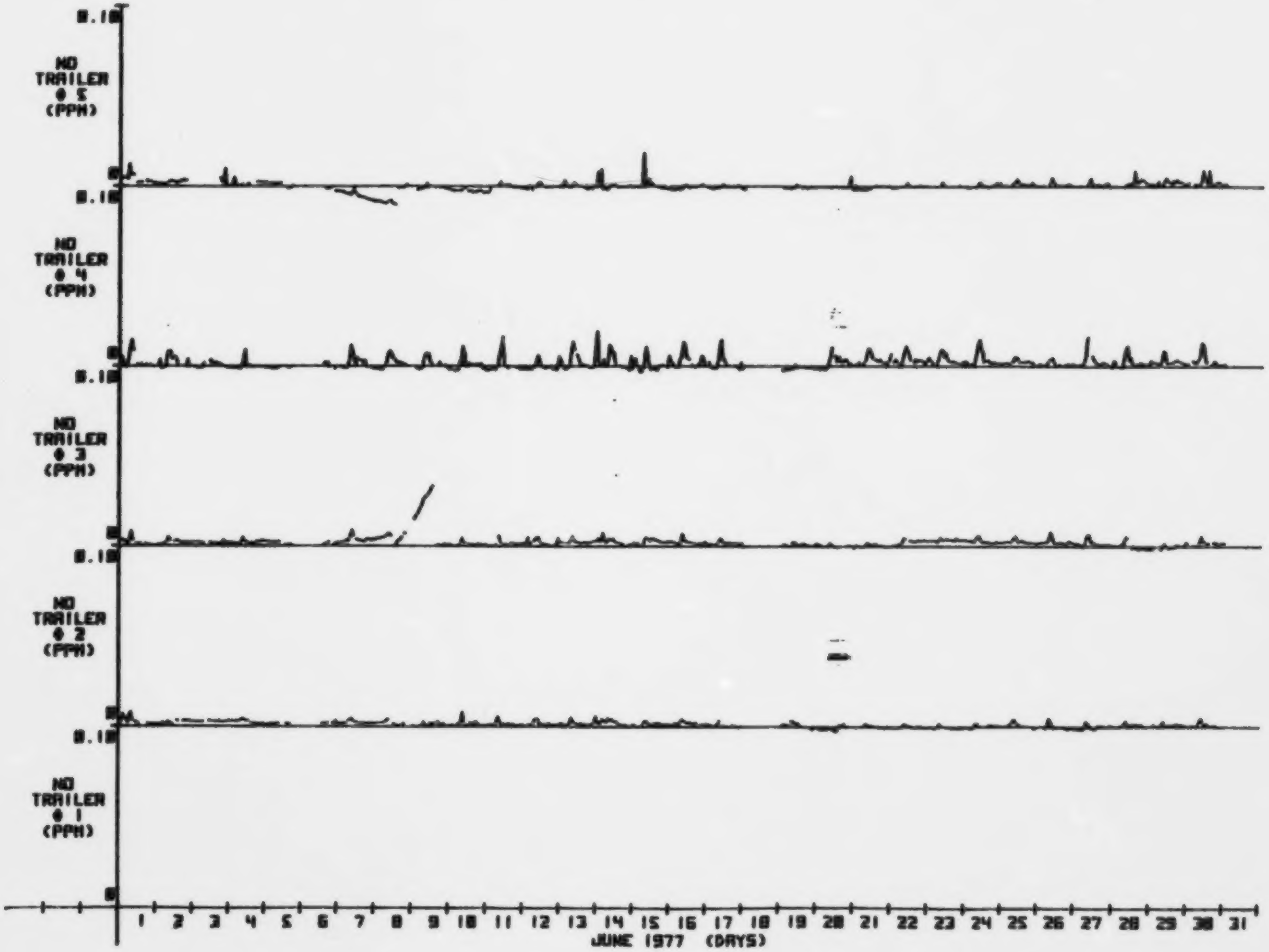

0.10
NO TRAILER # 5 (PPM)
0
0.10
NO TRAILER # 4 (PPM)
0
0.10
NO TRAILER # 3 (PPM)
0
0.10
NO TRAILER # 2 (PPM)
0
0.10
NO TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JUNE 1977 (DAYS)

Figure H-86.

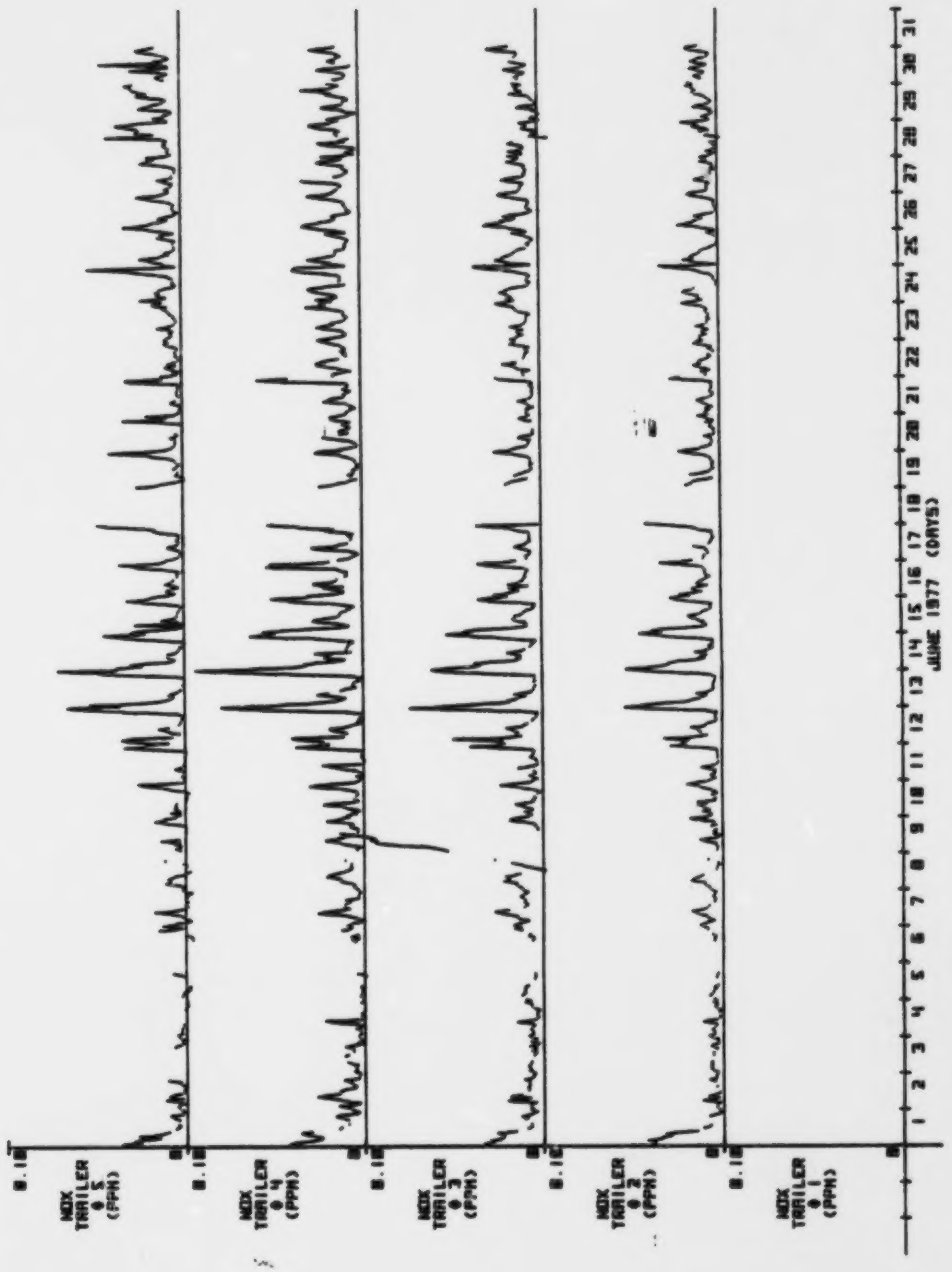

0.10
NOX TRAILER # 5 (PPM)
0
0.10
NOX TRAILER # 4 (PPM)
0
0.10
NOX TRAILER # 3 (PPM)
0
0.10
NOX TRAILER # 2 (PPM)
0
0.10
NOX TRAILER # 1 (PPM)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JUNE 1977 (DAYS)

Figure H-87.

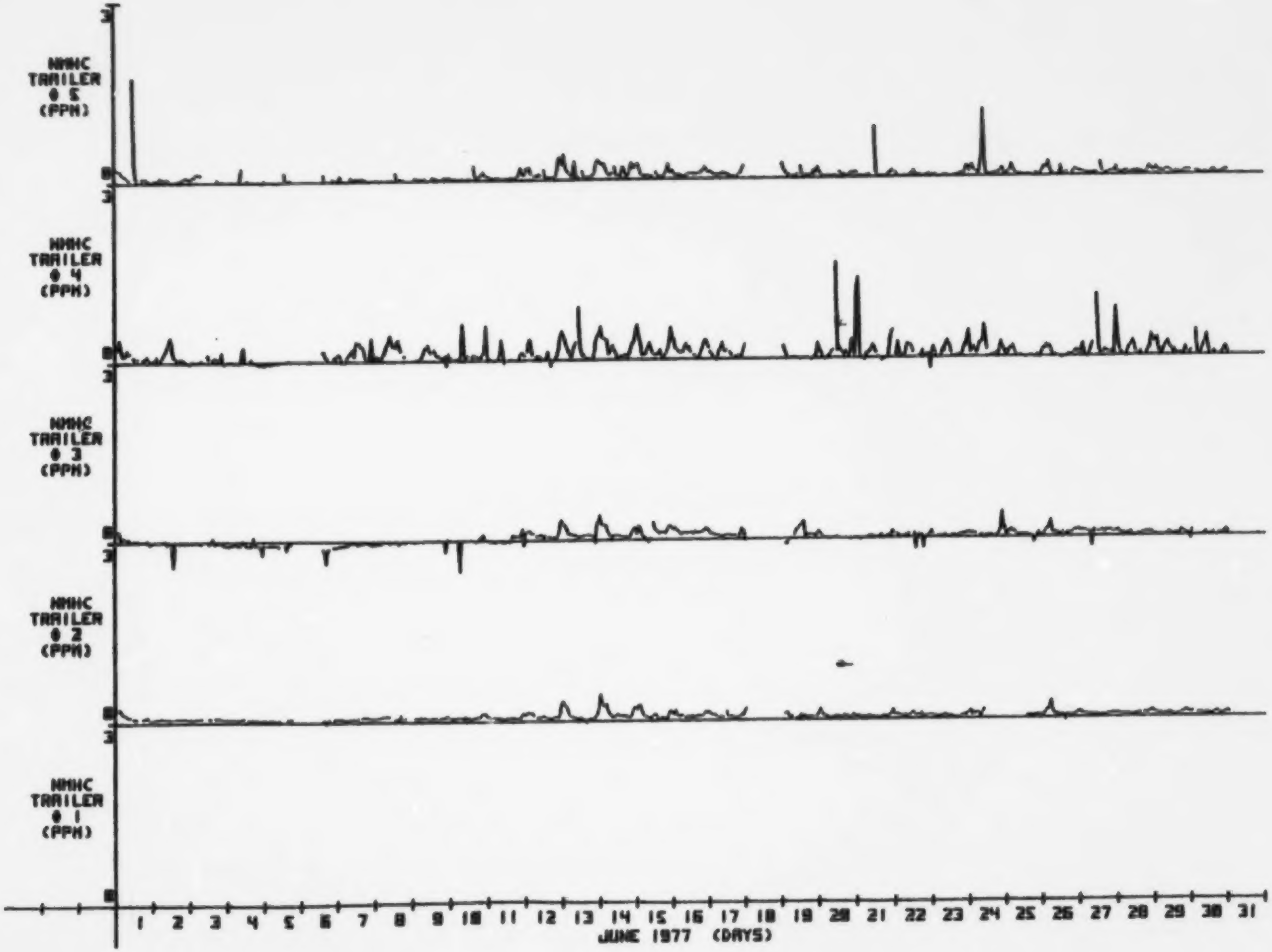

NMHC TRAILER # 5 (PPM)
NMHC TRAILER # 4 (PPM)
NMHC TRAILER # 3 (PPM)
NMHC TRAILER # 2 (PPM)
NMHC TRAILER # 1 (PPM)
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JUNE 1977 (DAYS)

Figure H-88.

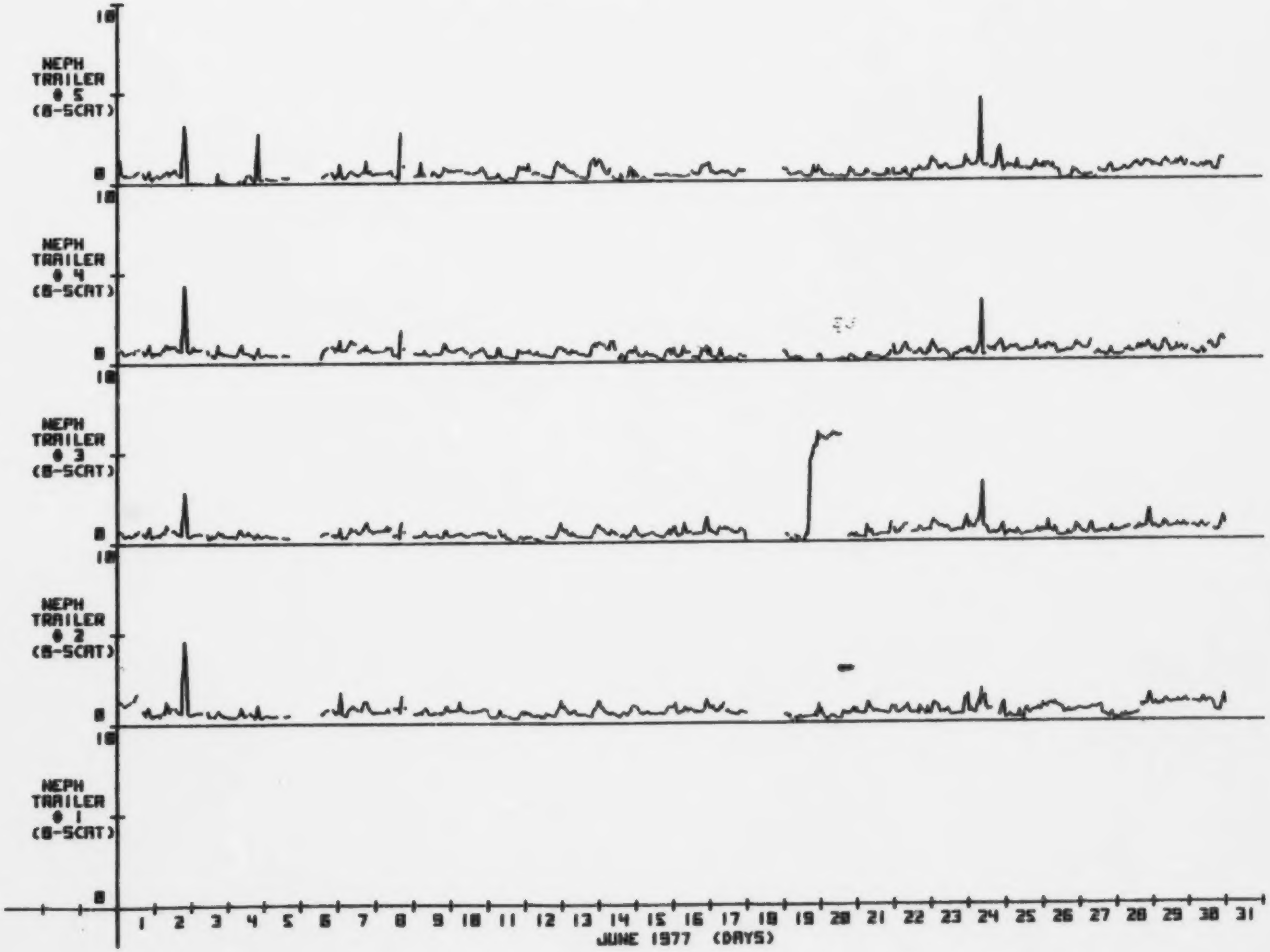

10
NEPH TRAILER # 5 (B-SCAT)
0
10
NEPH TRAILER # 4 (B-SCAT)
0
10
NEPH TRAILER # 3 (B-SCAT)
0
10
NEPH TRAILER # 2 (B-SCAT)
0
10
NEPH TRAILER # 1 (B-SCAT)
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JUNE 1977 (DAYS)

Figure H-89.

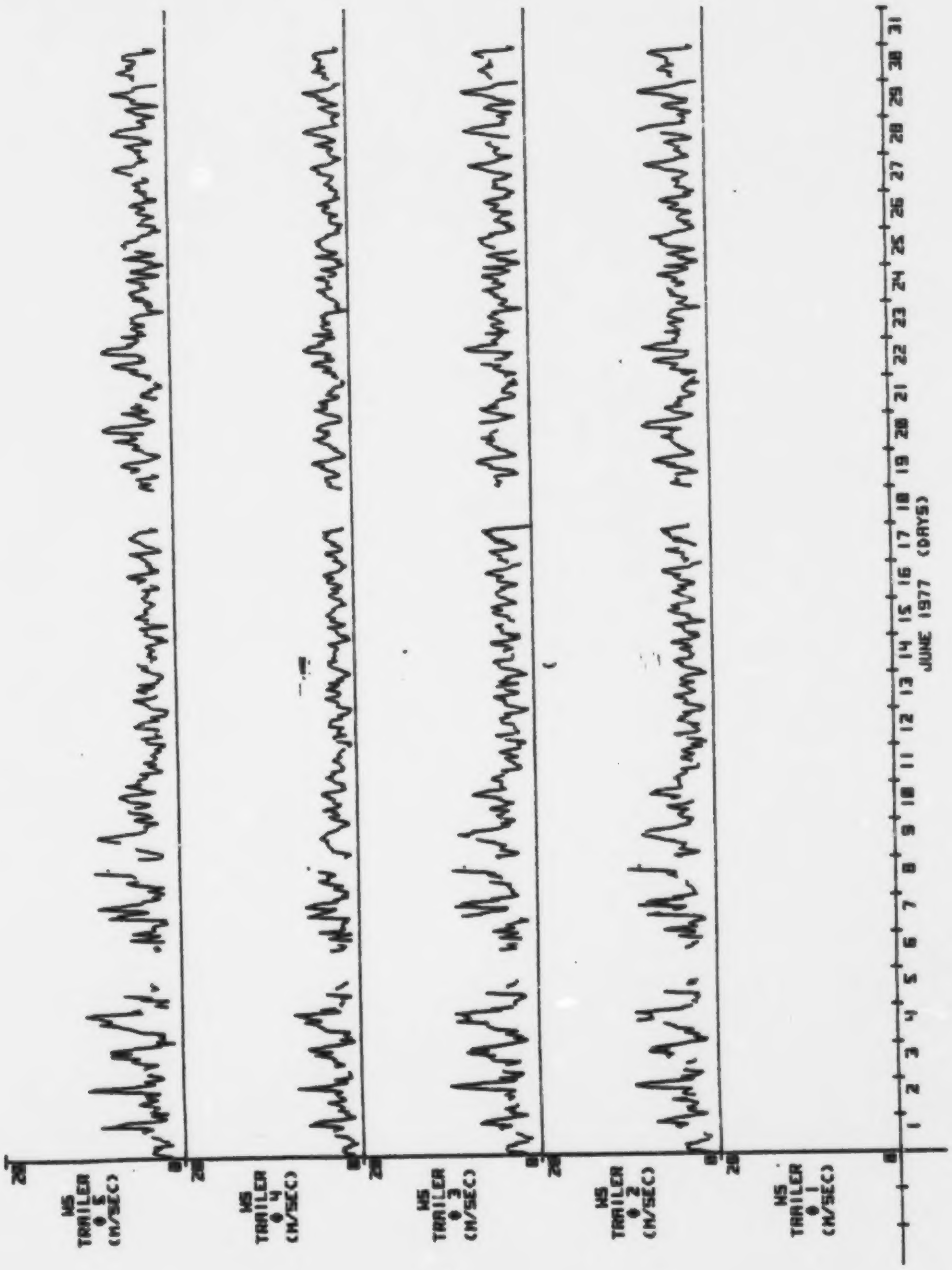

WS TRAILER # 5 (M/SEC)
WS TRAILER # 4 (M/SEC)
WS TRAILER # 3 (M/SEC)
WS TRAILER # 2 (M/SEC)
WS TRAILER # 1 (M/SEC)
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JUNE 1977 (DAYS)

Figure H-90.

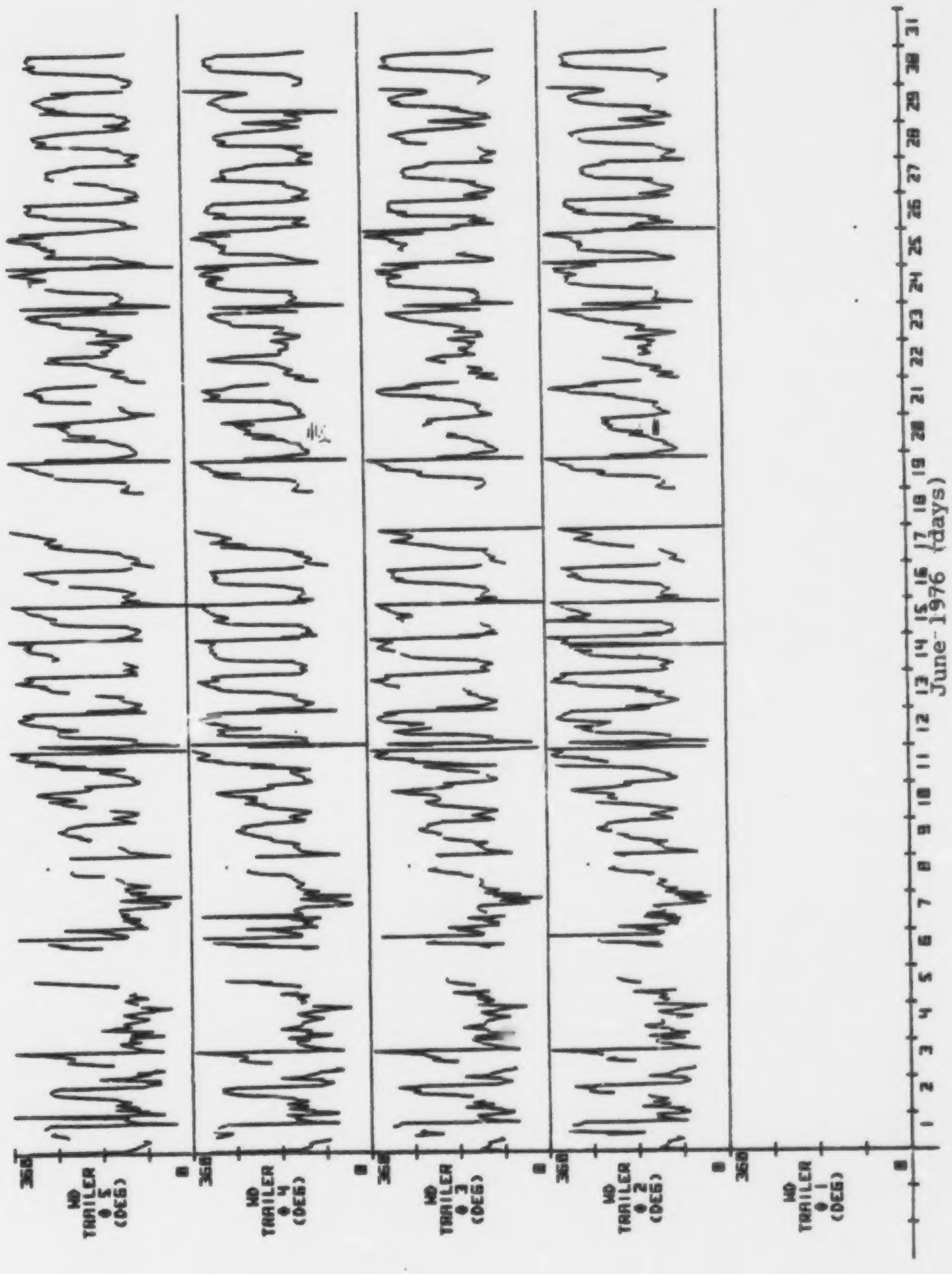

360
WD TRAILER # 5 (DEG)
0
360
WD TRAILER # 4 (DEG)
0
360
WD TRAILER # 3 (DEG)
0
360
WD TRAILER # 2 (DEG)
0
360
WD TRAILER # 1 (DEG)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
June 1976 (days)

Figure H-91.

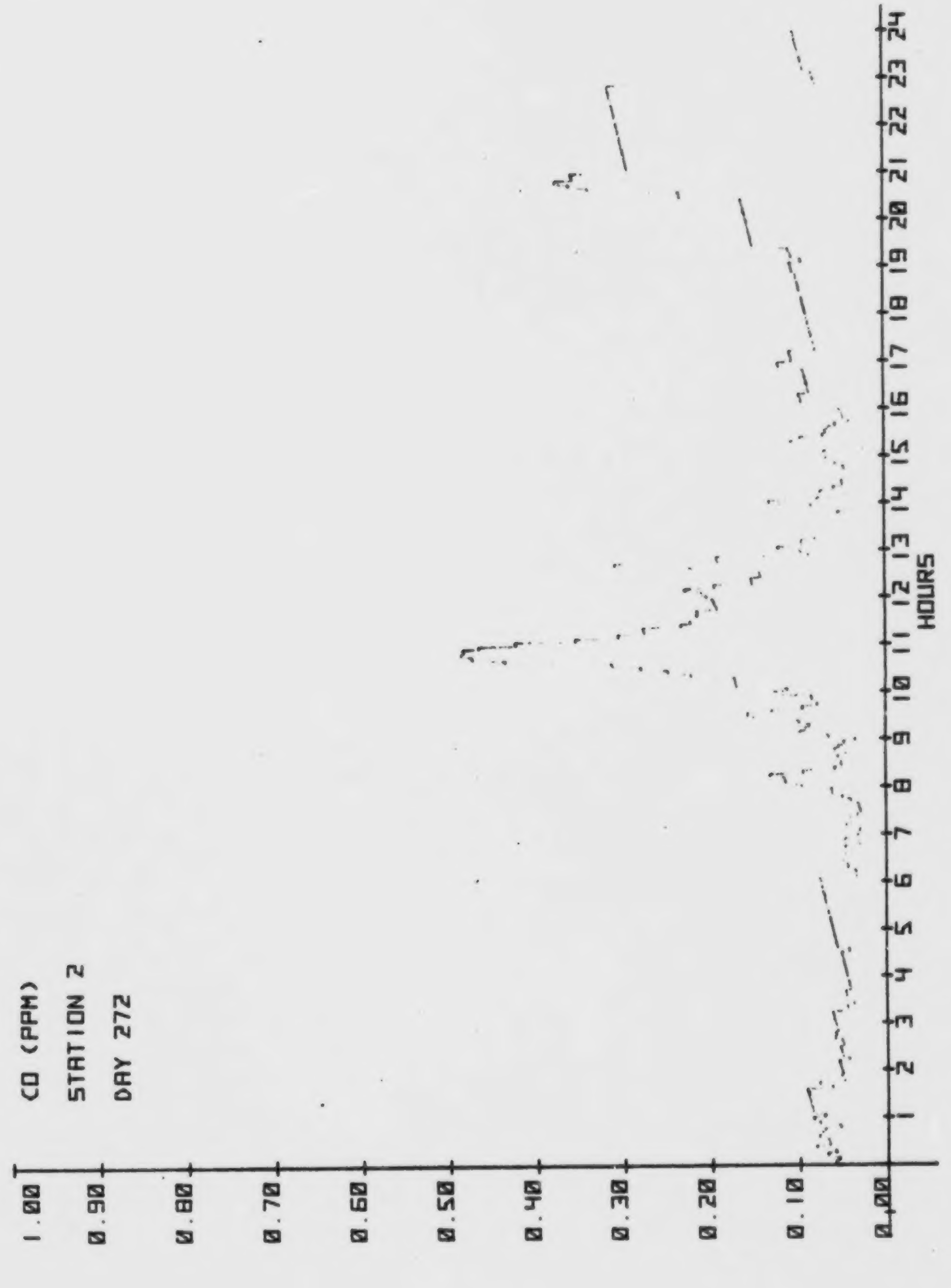

CO (PPM)
STATION 2
DAY 272
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-92.

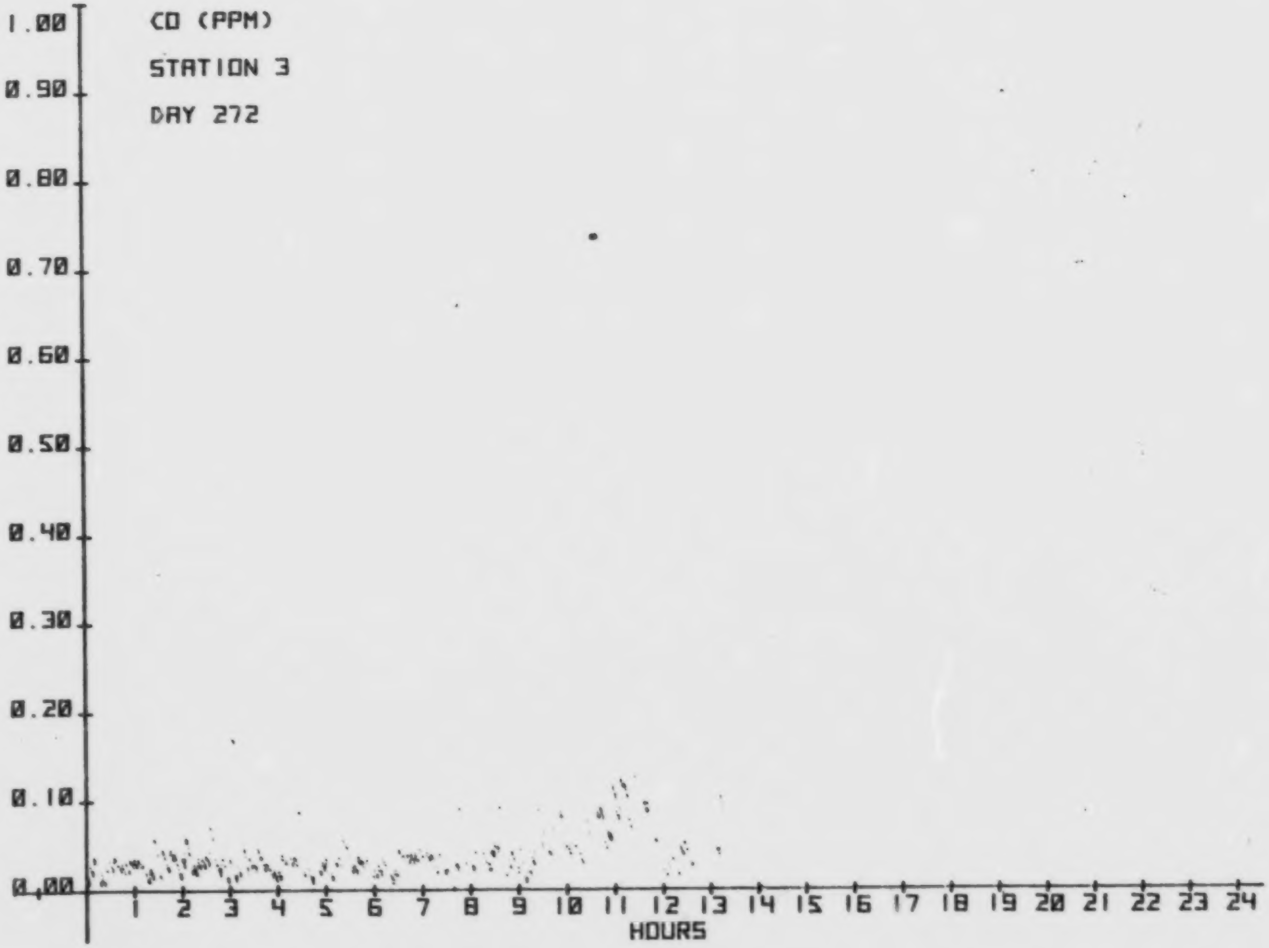

CO (PPM)
STATION 3
DAY 272
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-93.

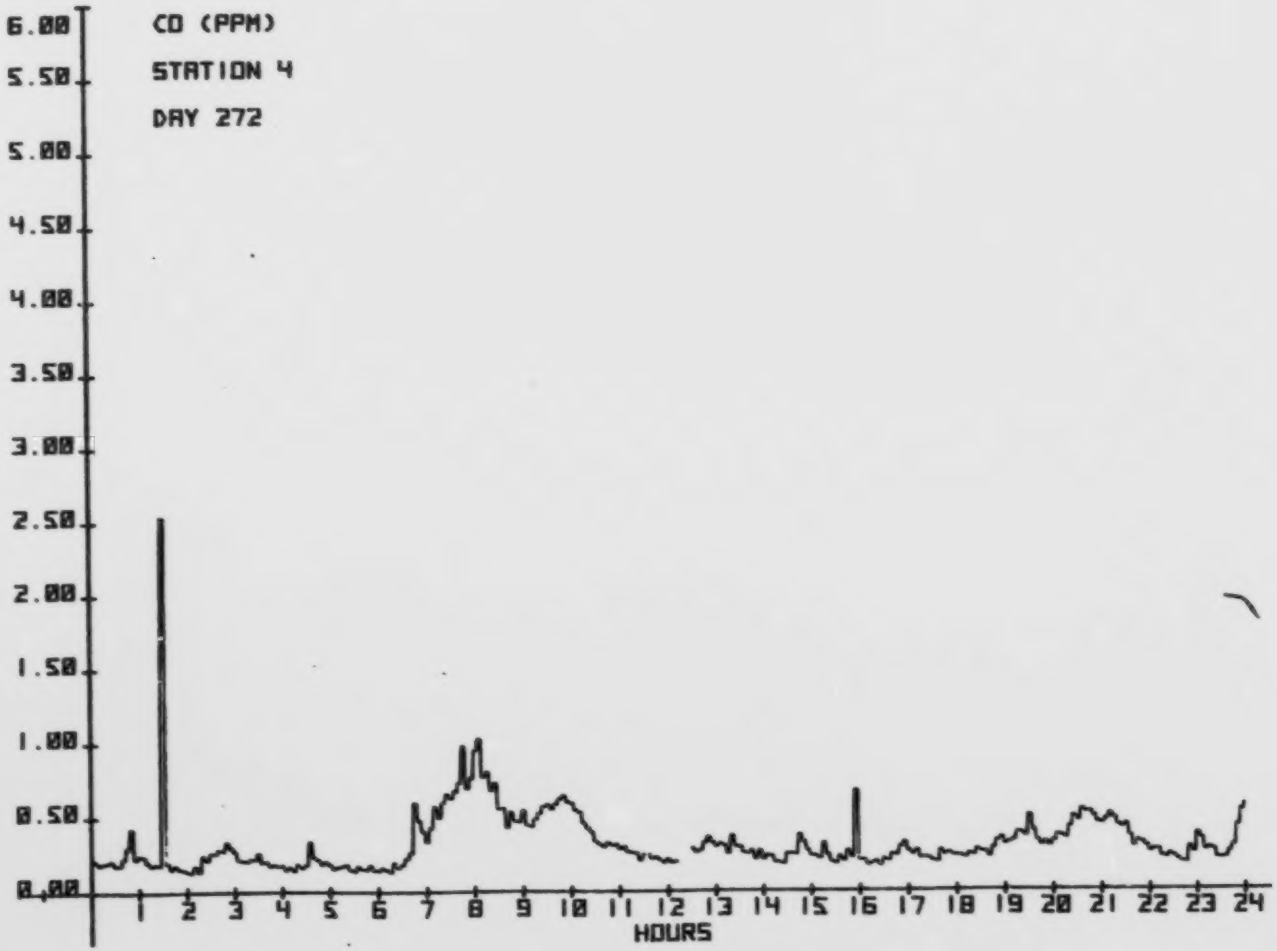

CO (PPM)
STATION 4
DAY 272
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-94.

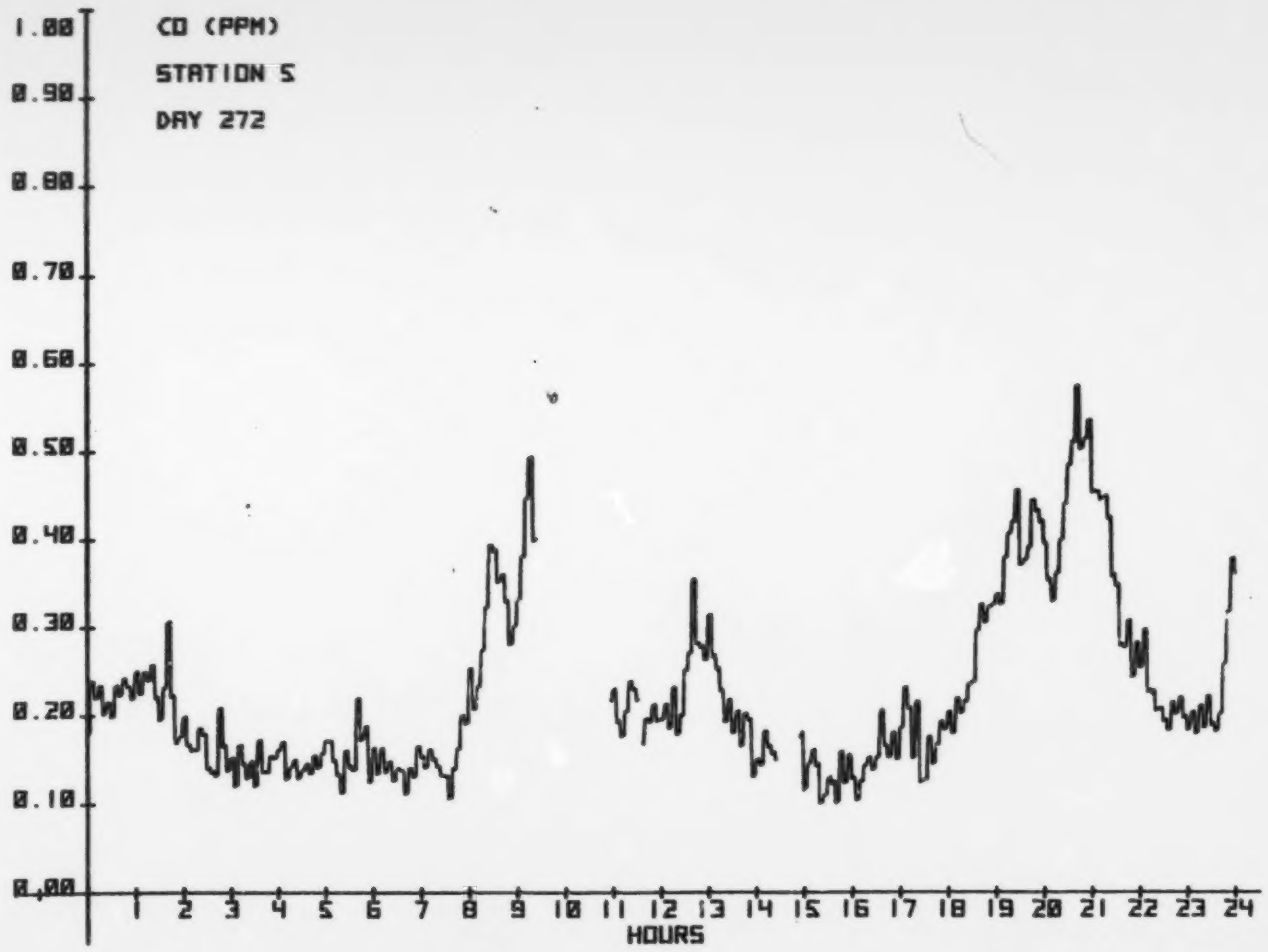

CO (PPM)
STATION 5
DAY 272
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-95.

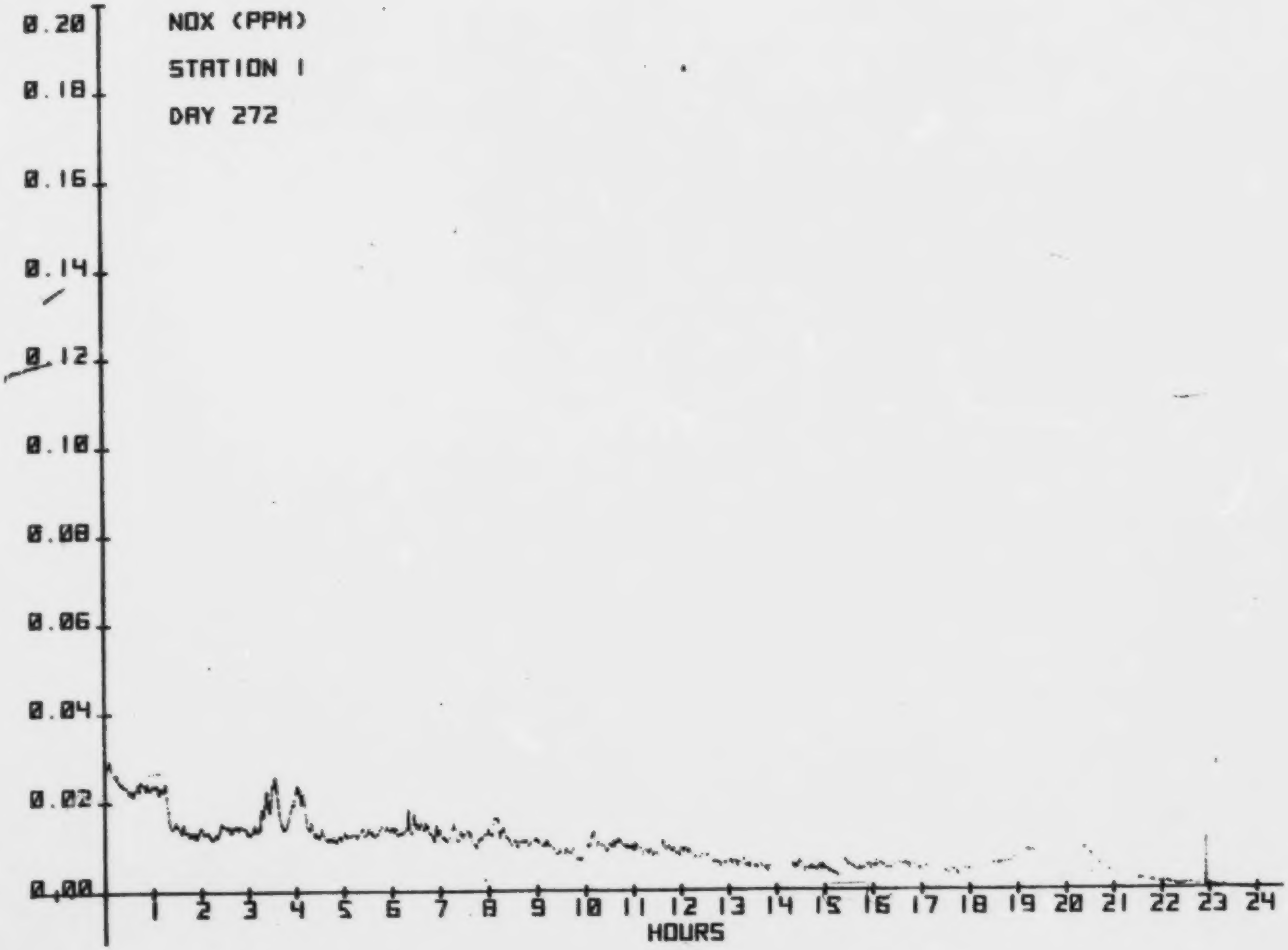

NOX (PPM)
STATION 1
DAY 272
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-96.

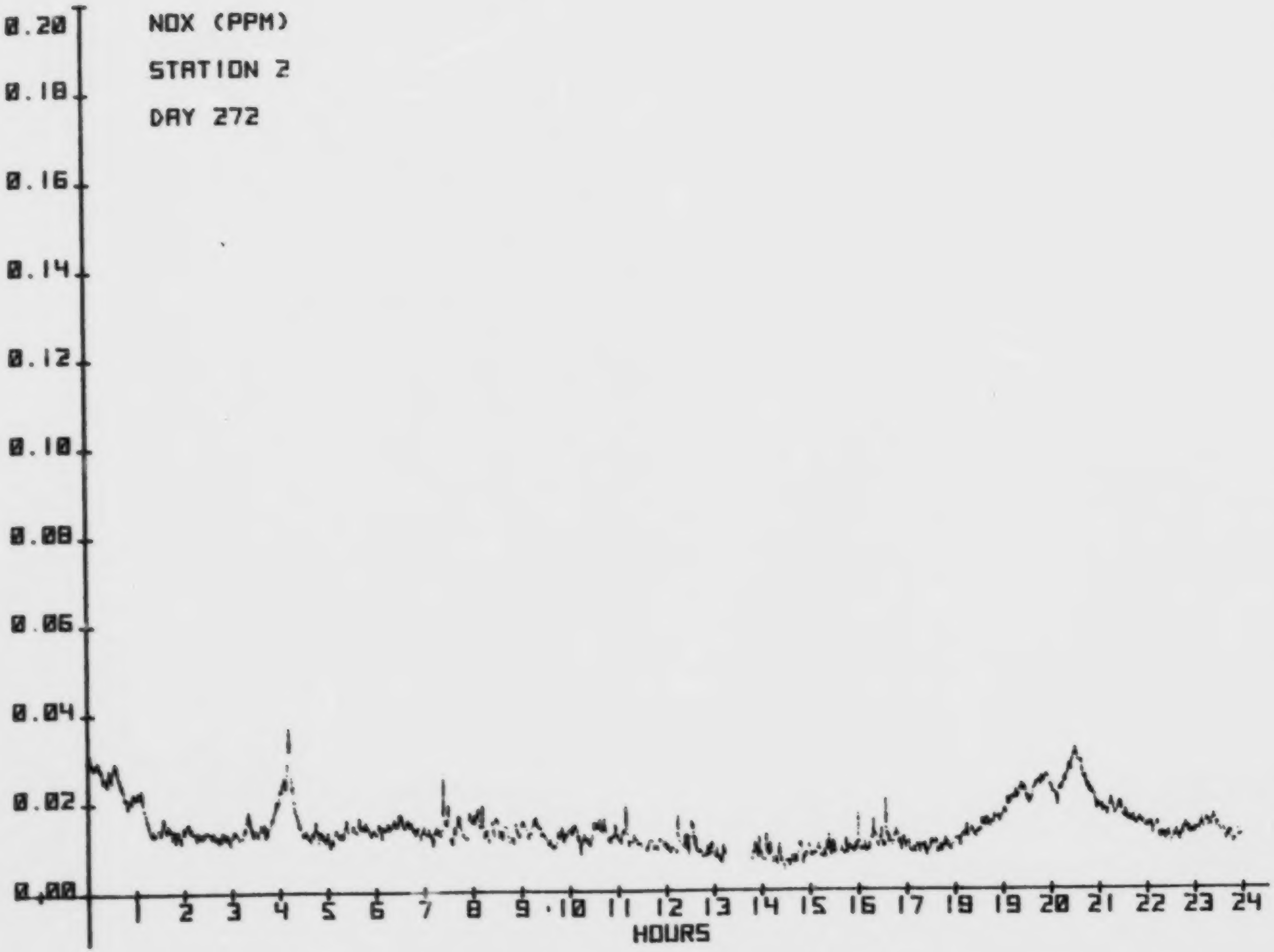

NOX (PPM)
STATION 2
DAY 272
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-97.

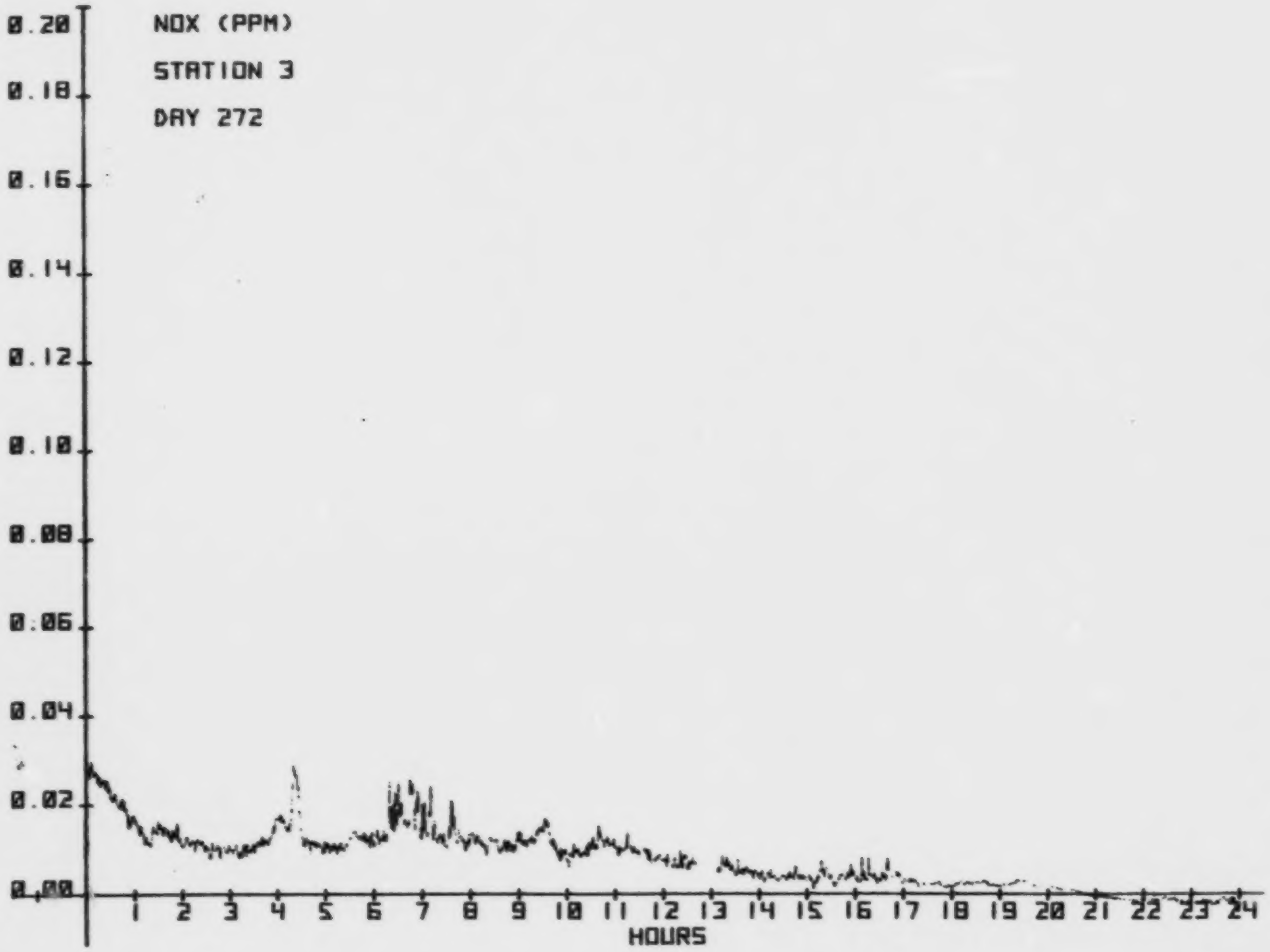
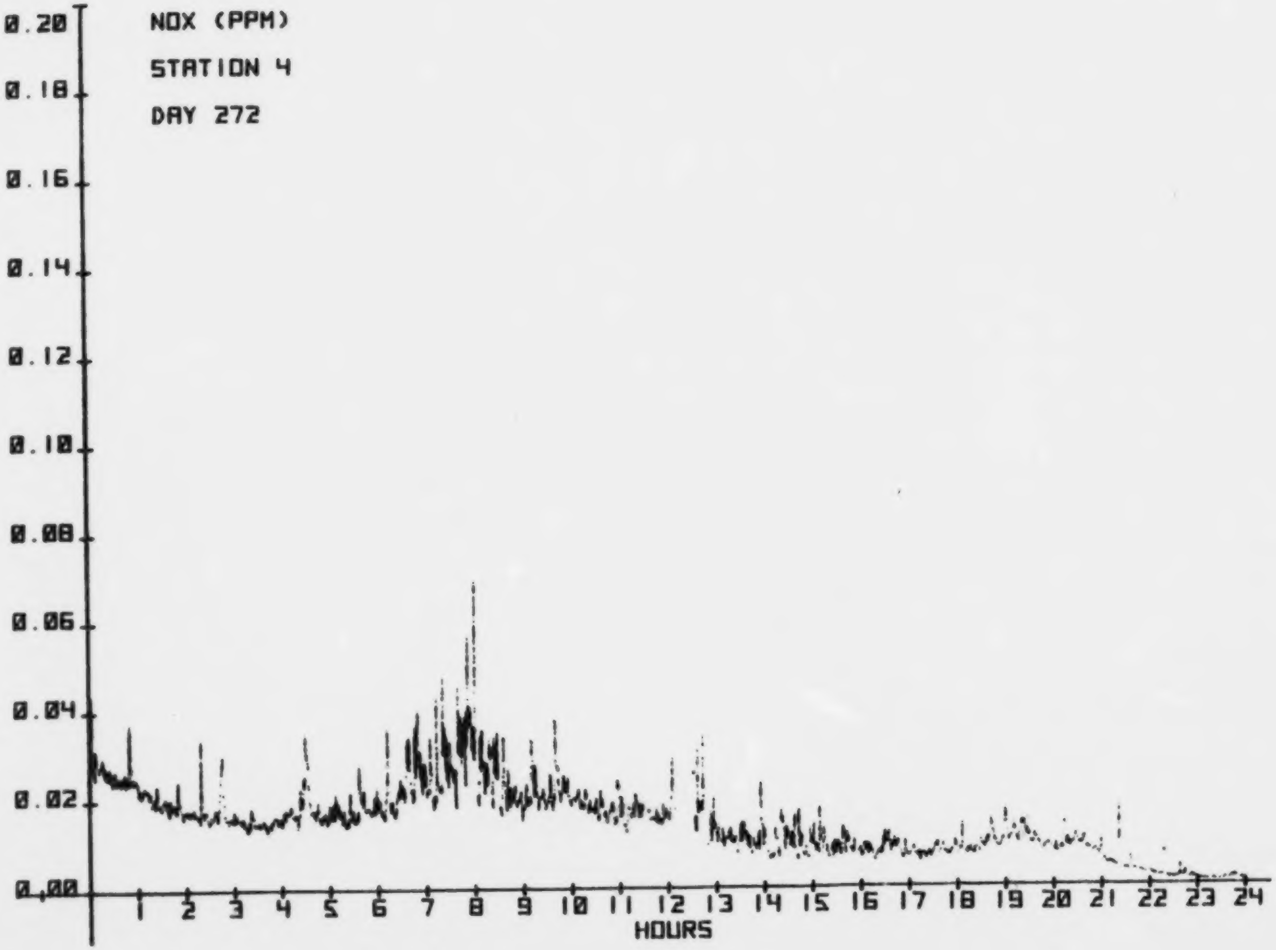

0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
NOX (PPM)
STATION 3
DAY 272
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-98.



0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
NOX (PPM)
STATION 4
DAY 272
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-99.

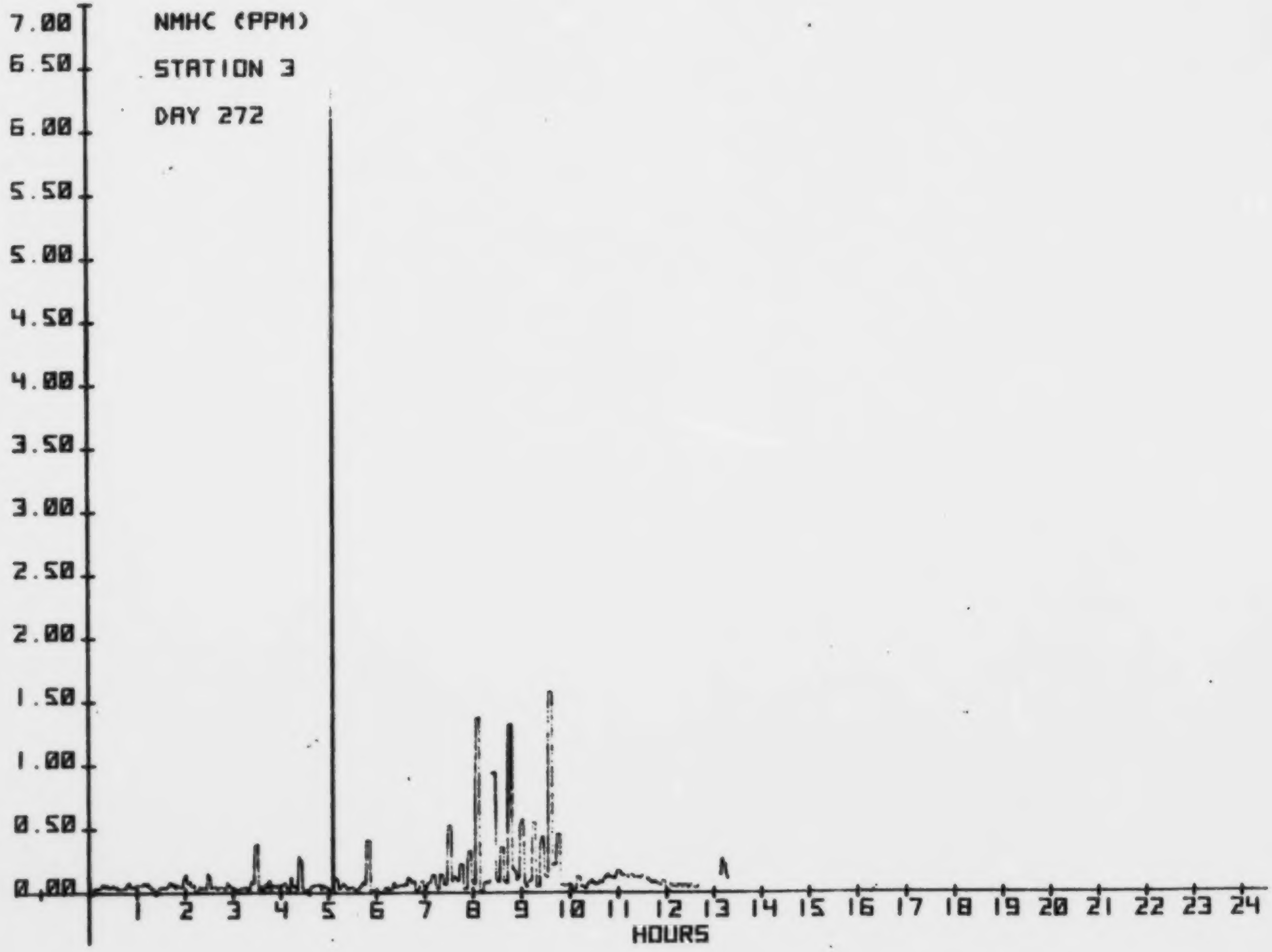

NMHC (PPM)
STATION 3
DAY 272
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-100.

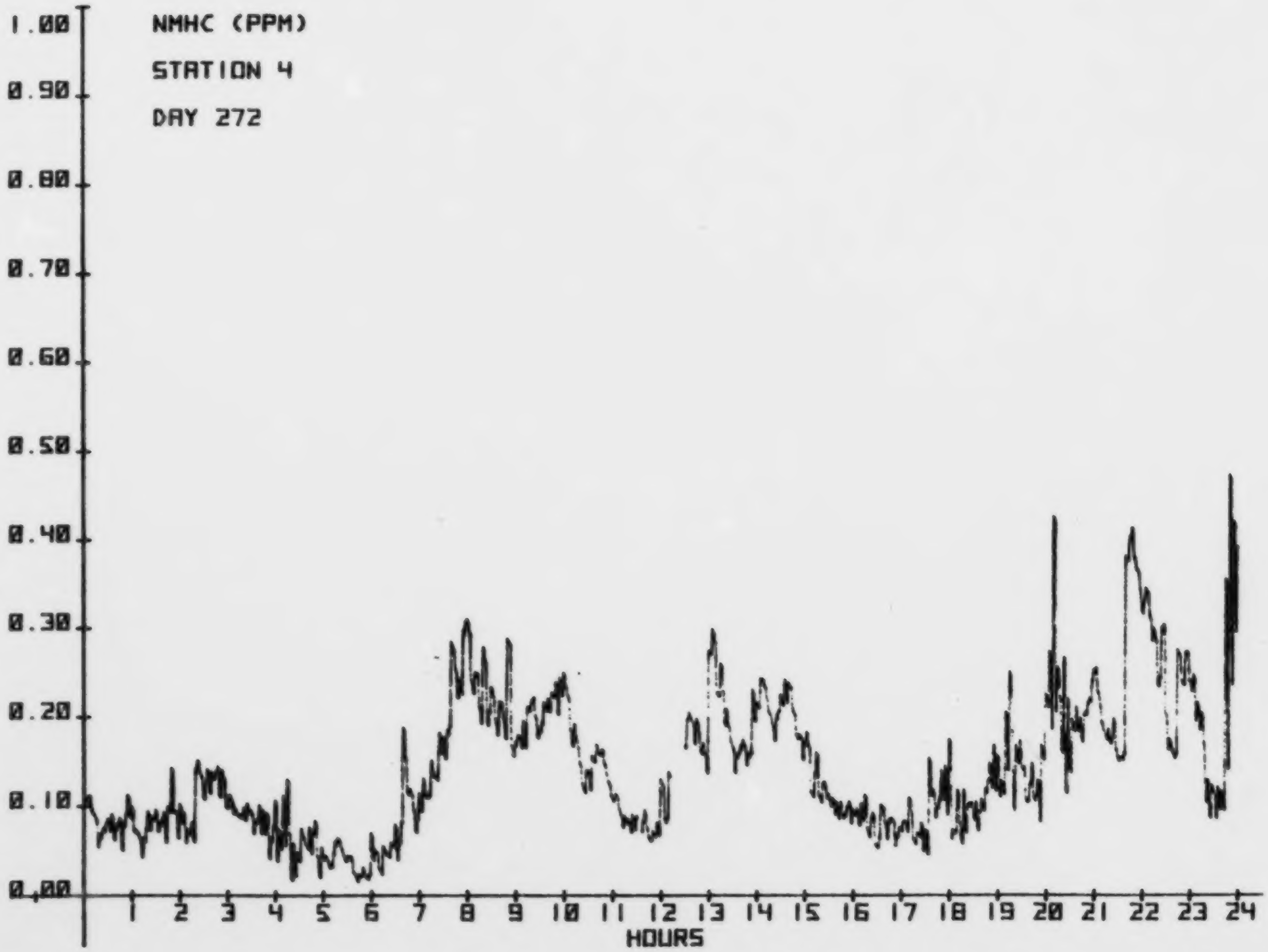

NMHC (PPM)
STATION 4
DAY 272
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-101.

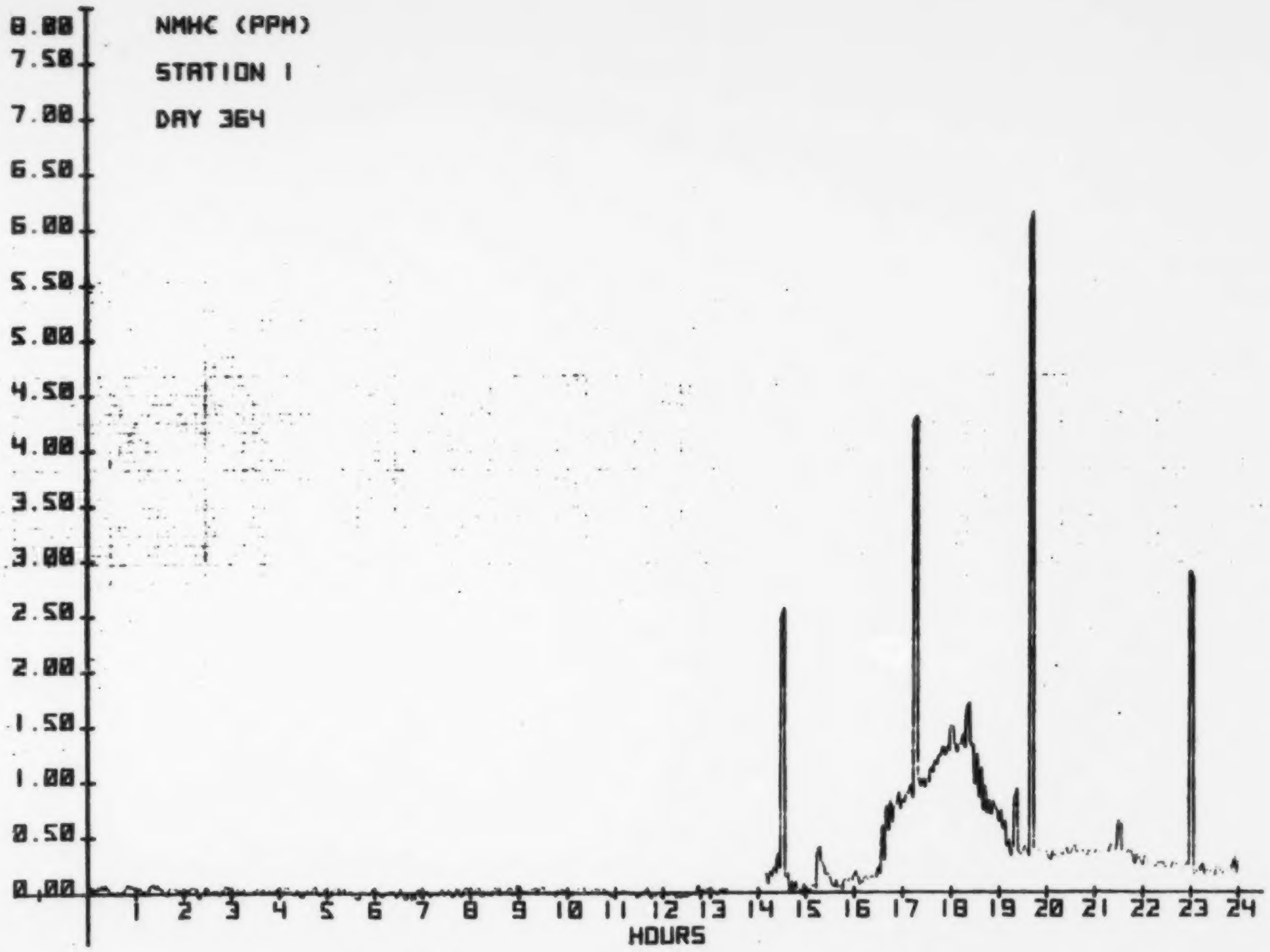

NMHC (PPM)
STATION 1
DAY 364
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-102.

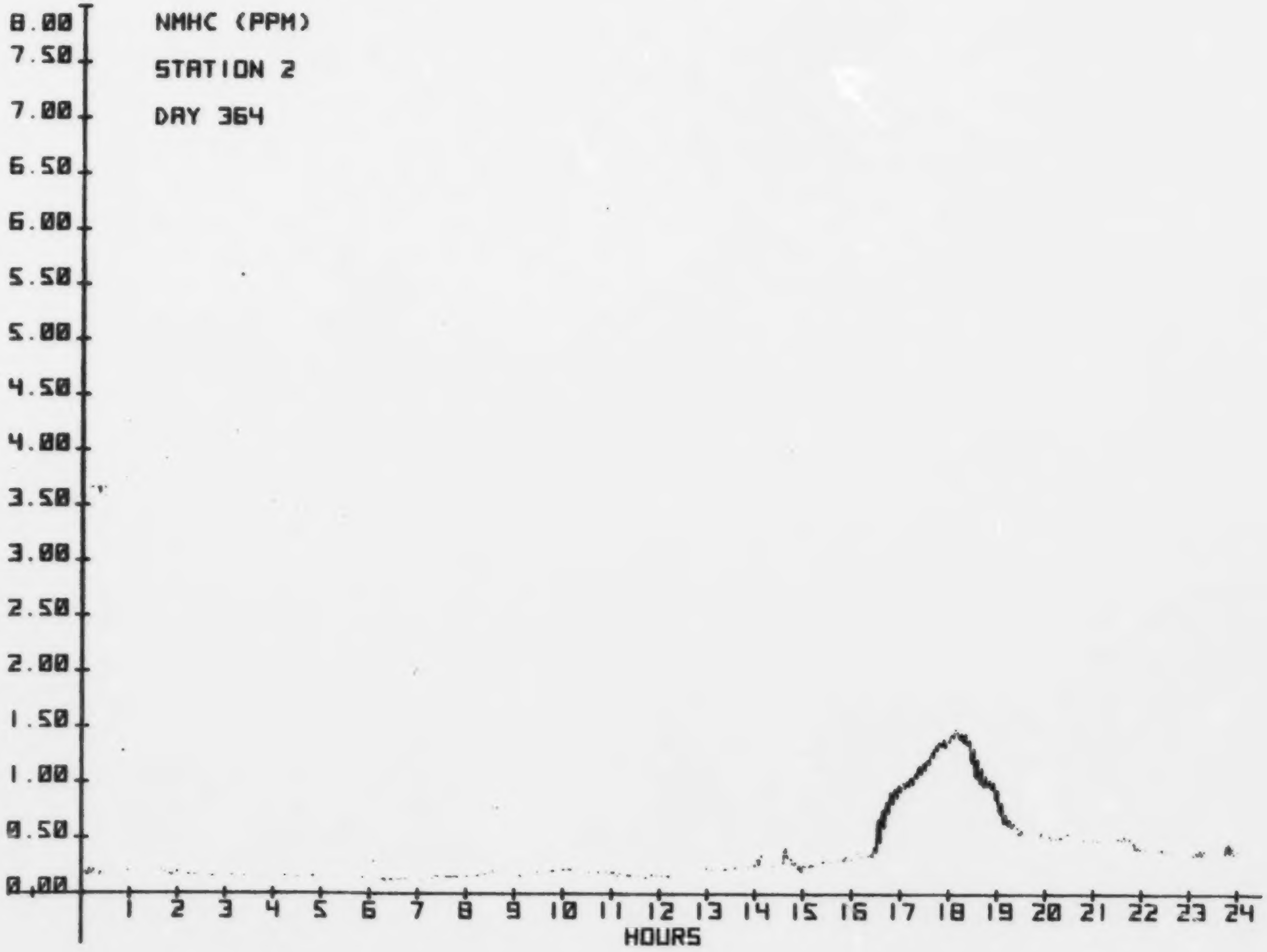

NMHC (PPM)
STATION 2
DAY 364
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-103.

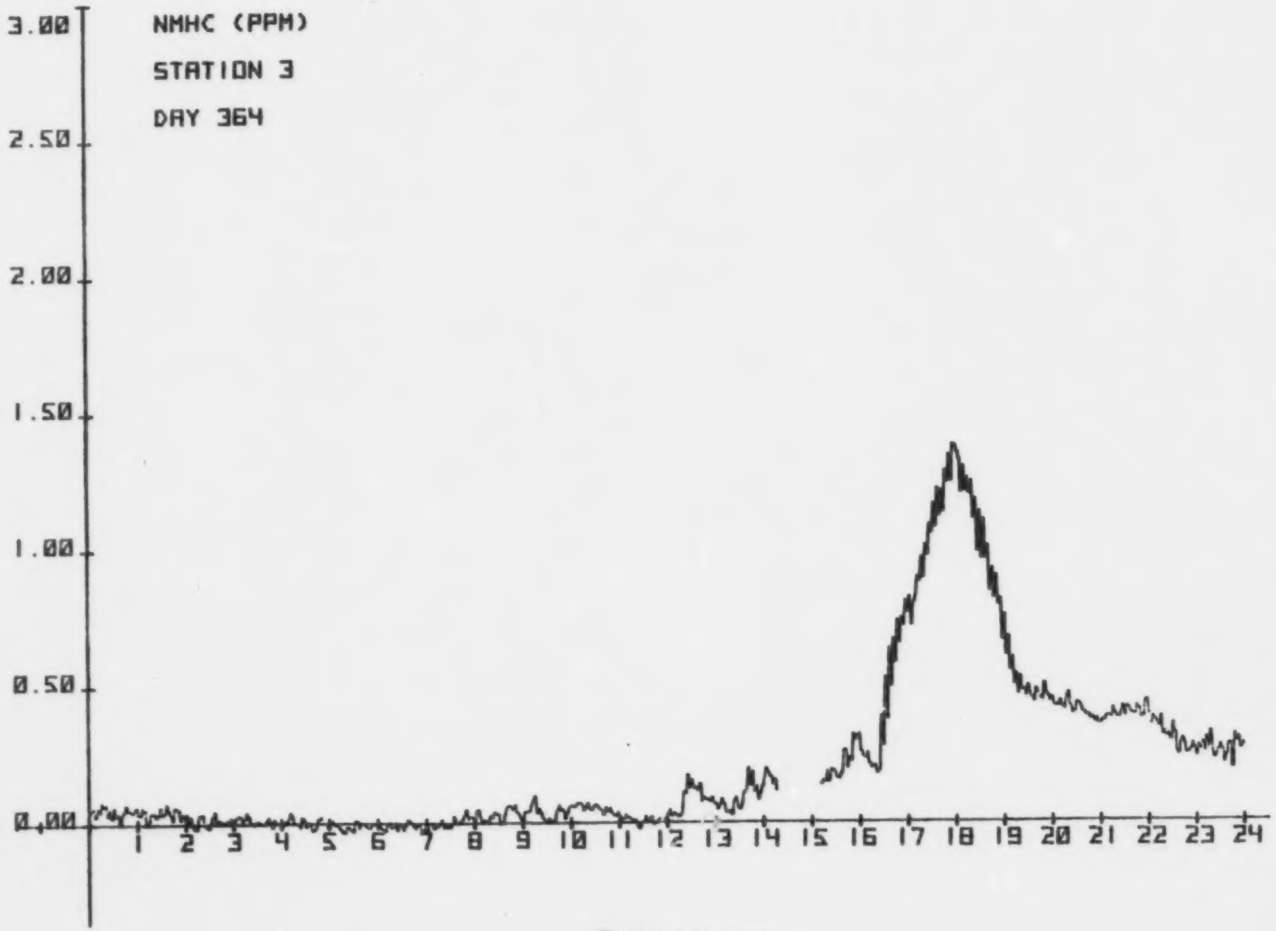

NMHC (PPM)
STATION 3
DAY 364
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Figure H-104.

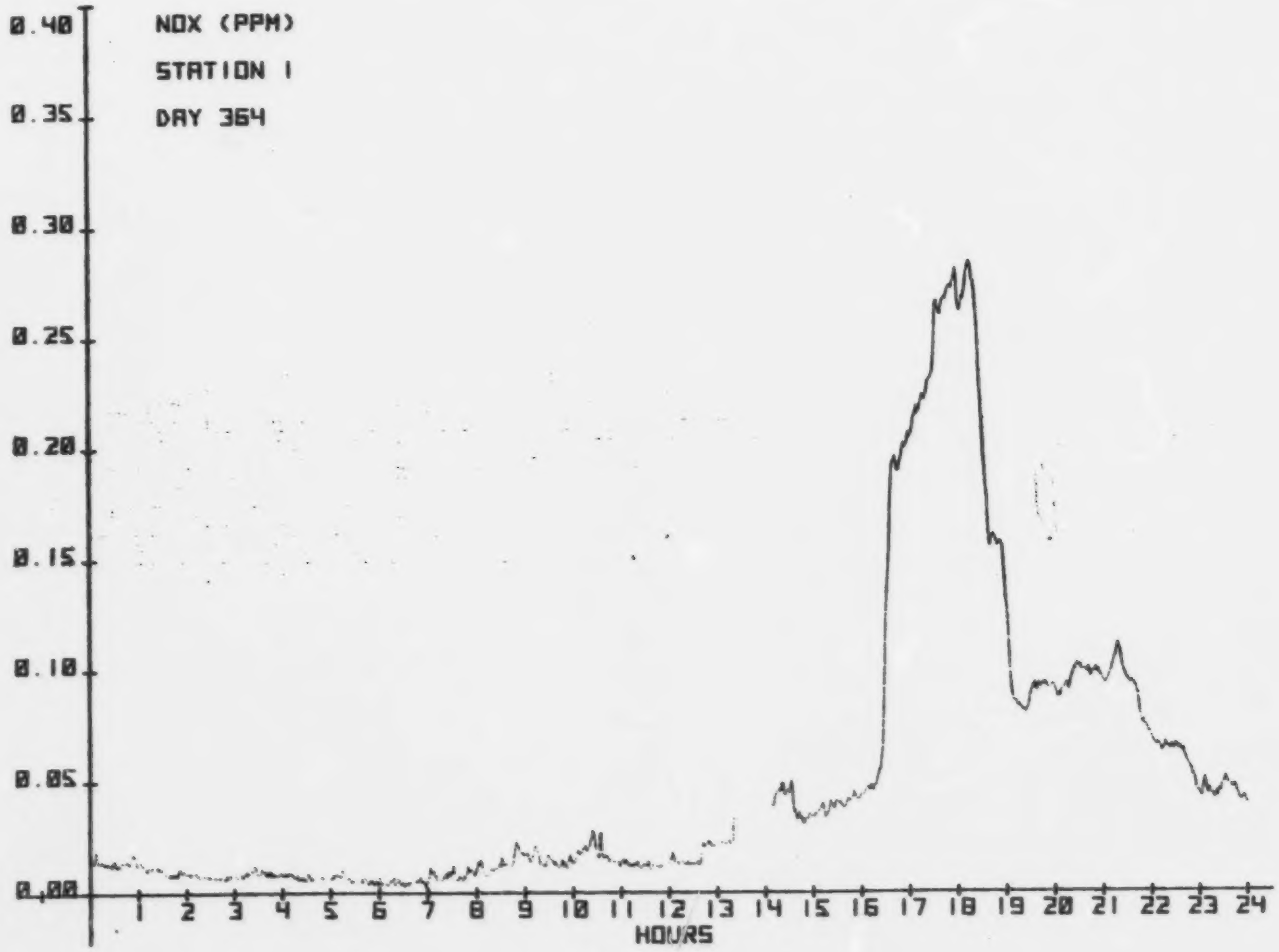

NOX (PPM)
STATION 1
DAY 364
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-105.

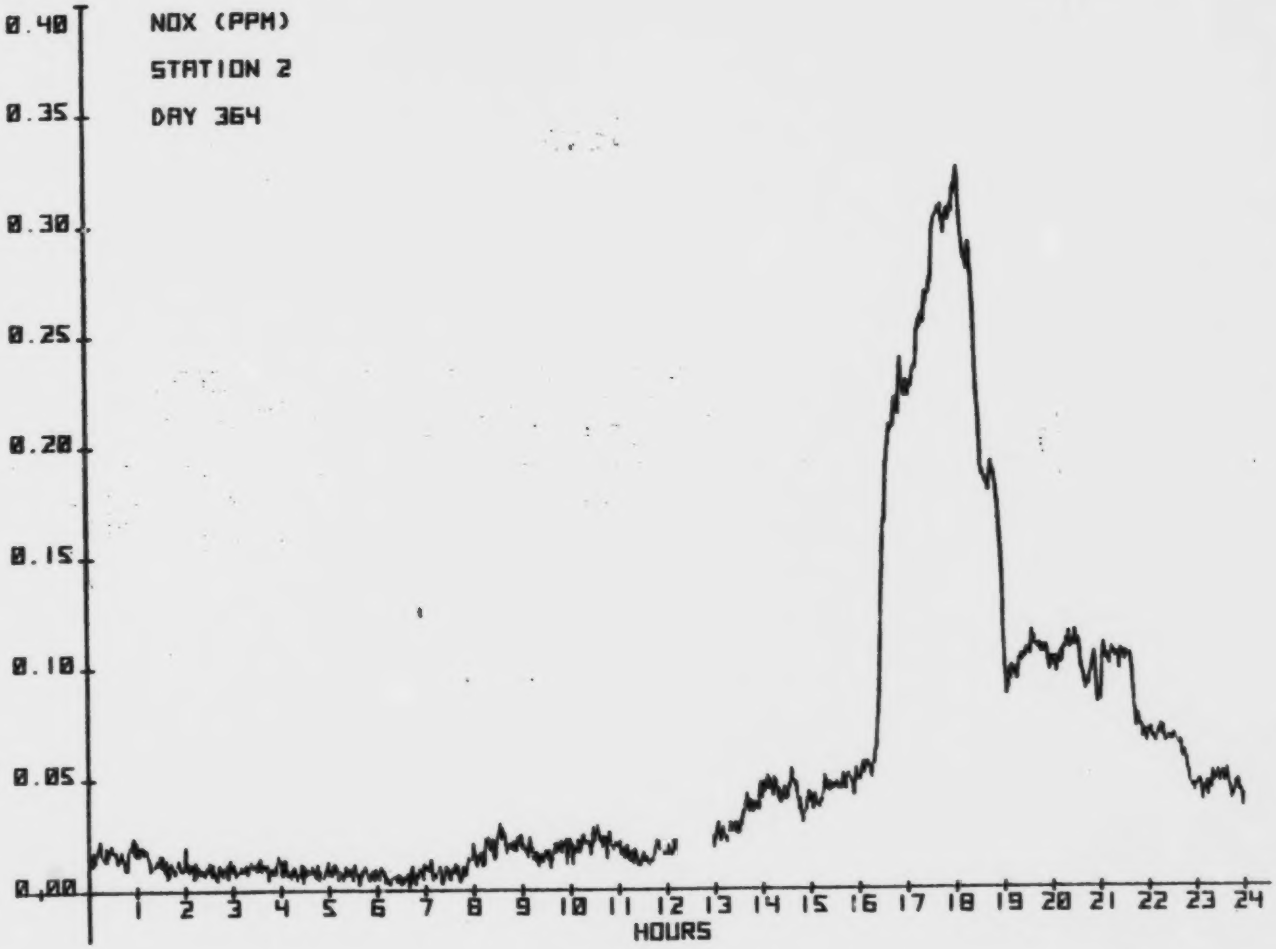

NOX (PPM)
STATION 2
DAY 364
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-106.

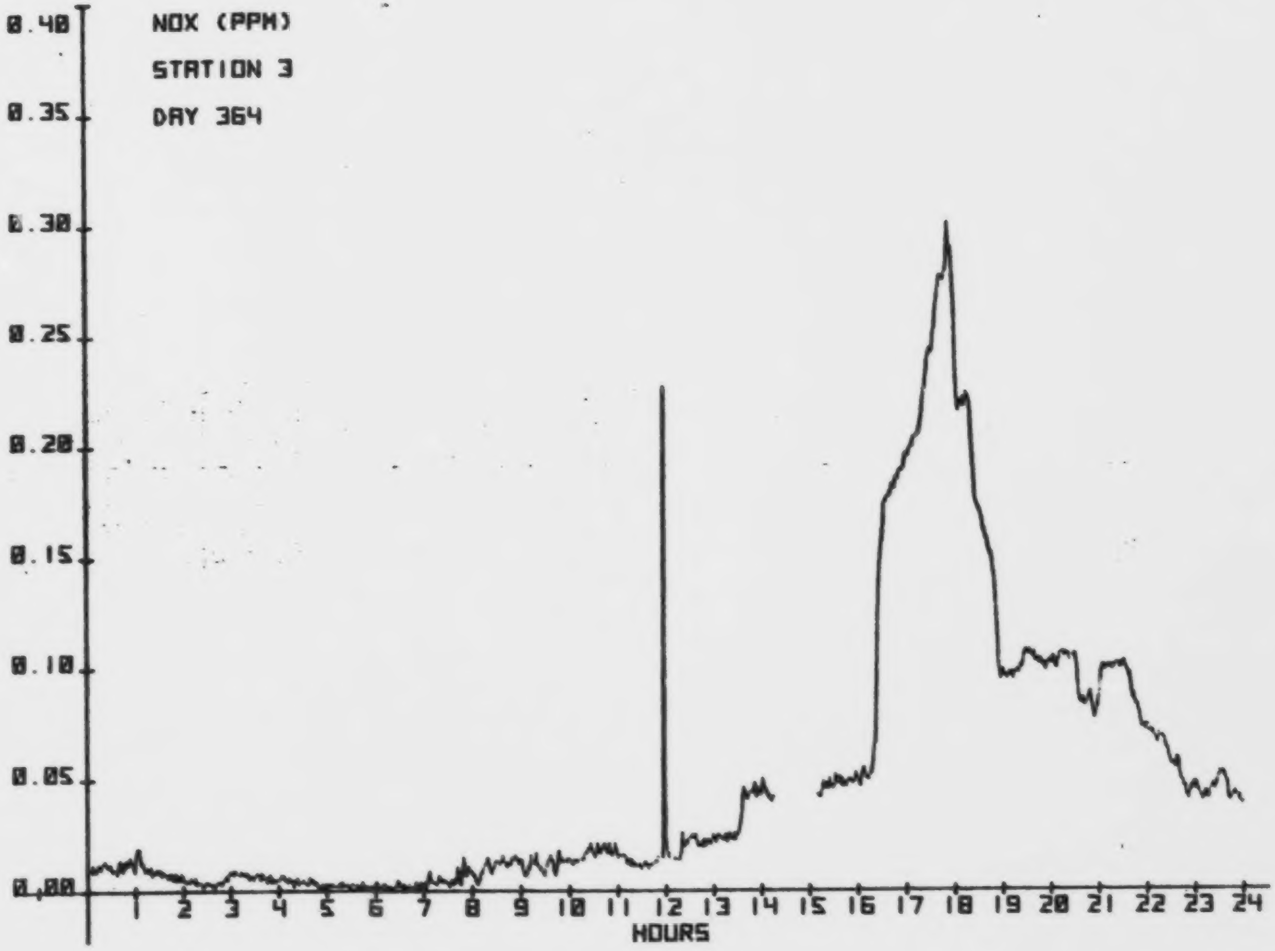

NOX (PPM)
STATION 3
DAY 364
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-107.

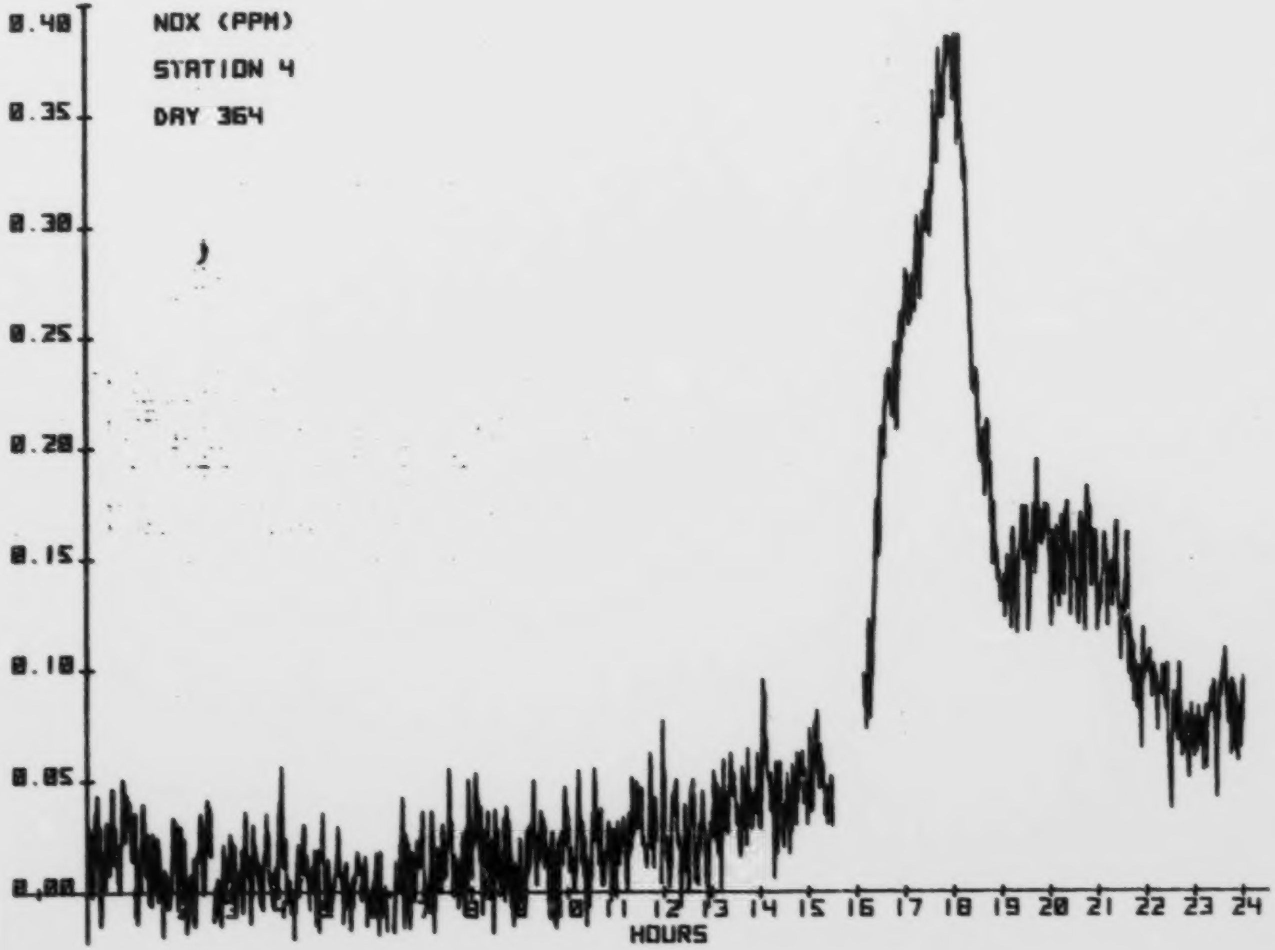

NOX (PPM)
STATION 4
DAY 364
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
HOURS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Figure H-108.

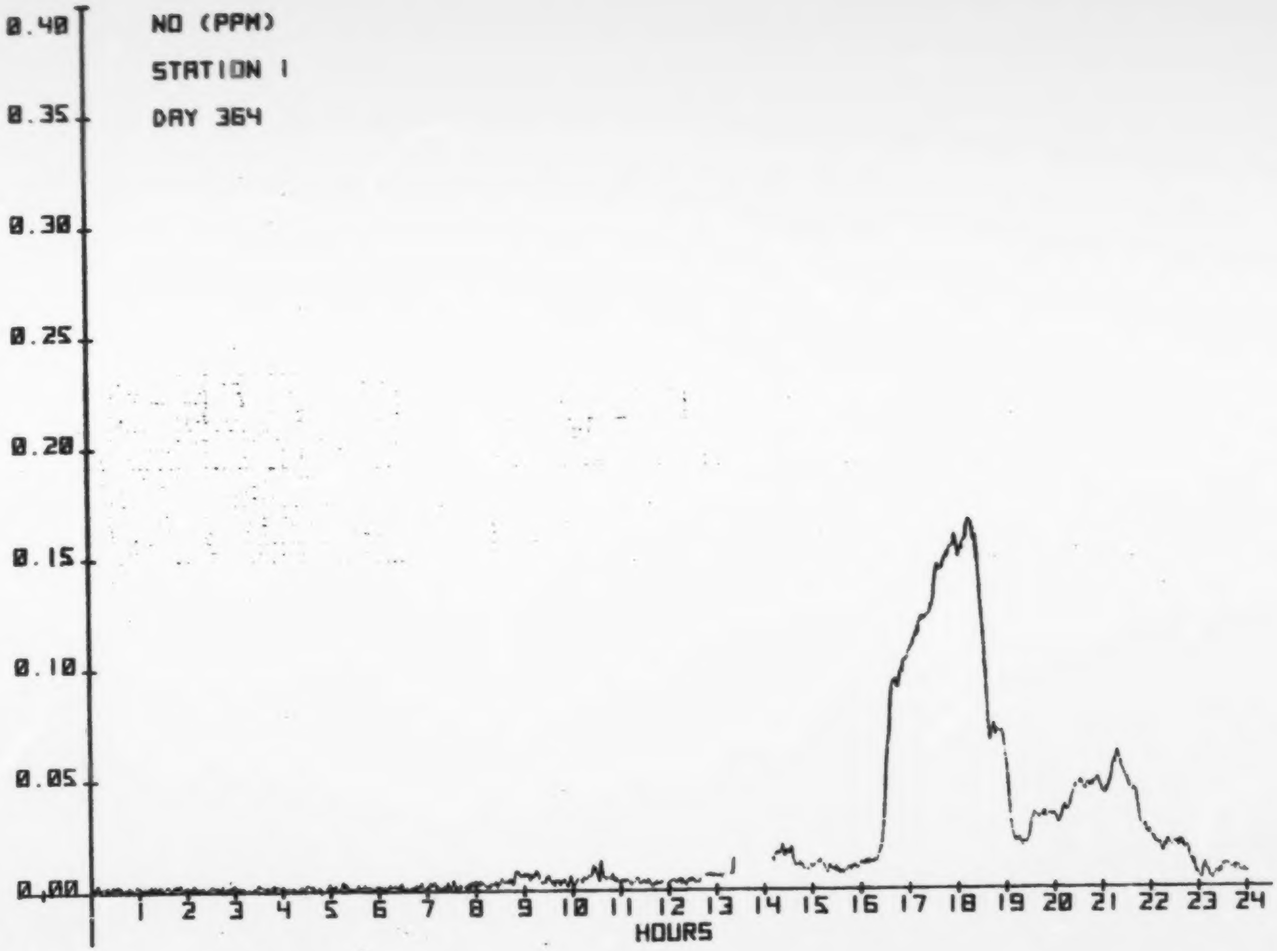

NO (PPM)
STATION 1
DAY 364
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-109.

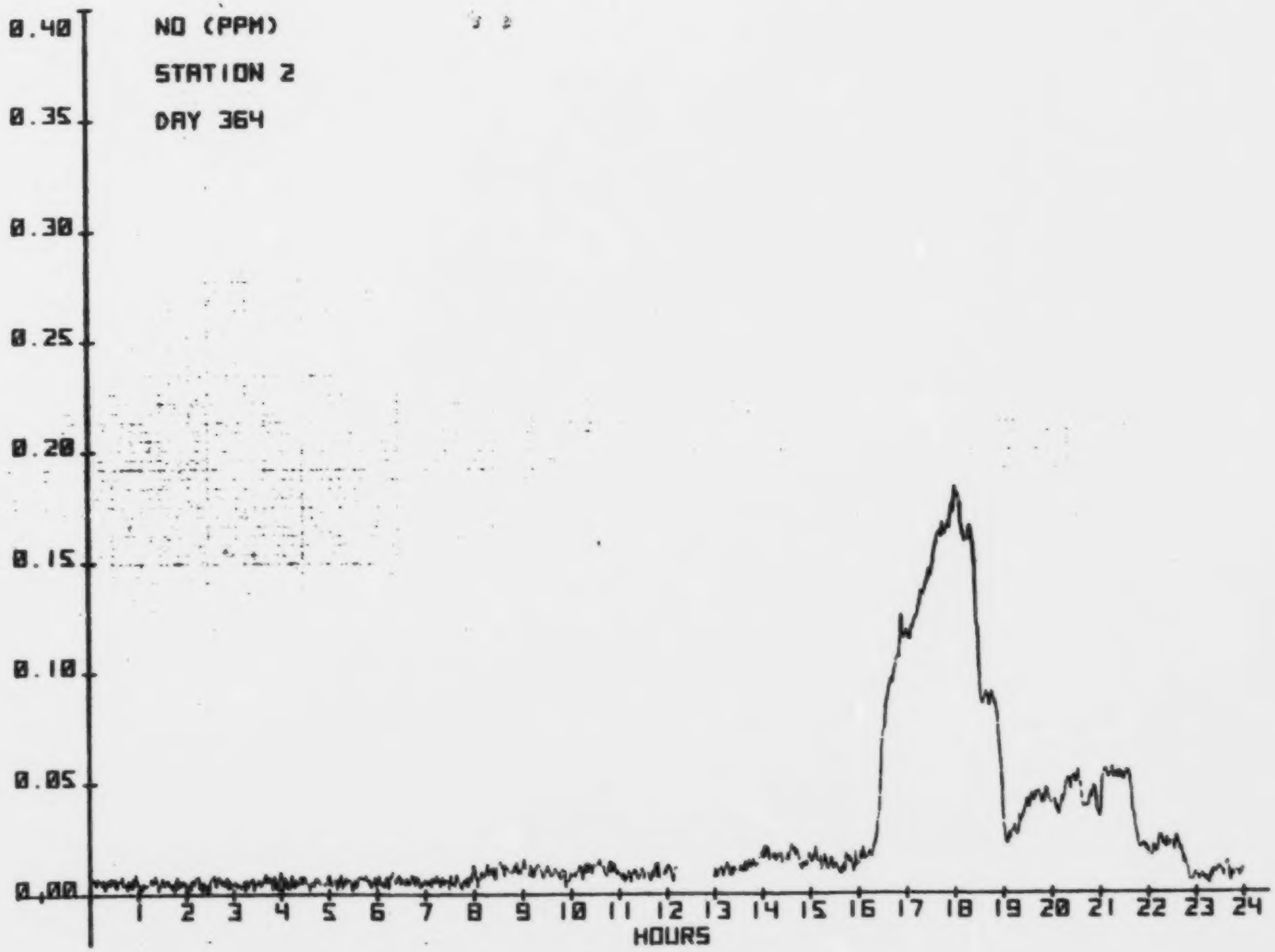

0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
NO (PPM)
STATION 2
DAY 364
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-110.

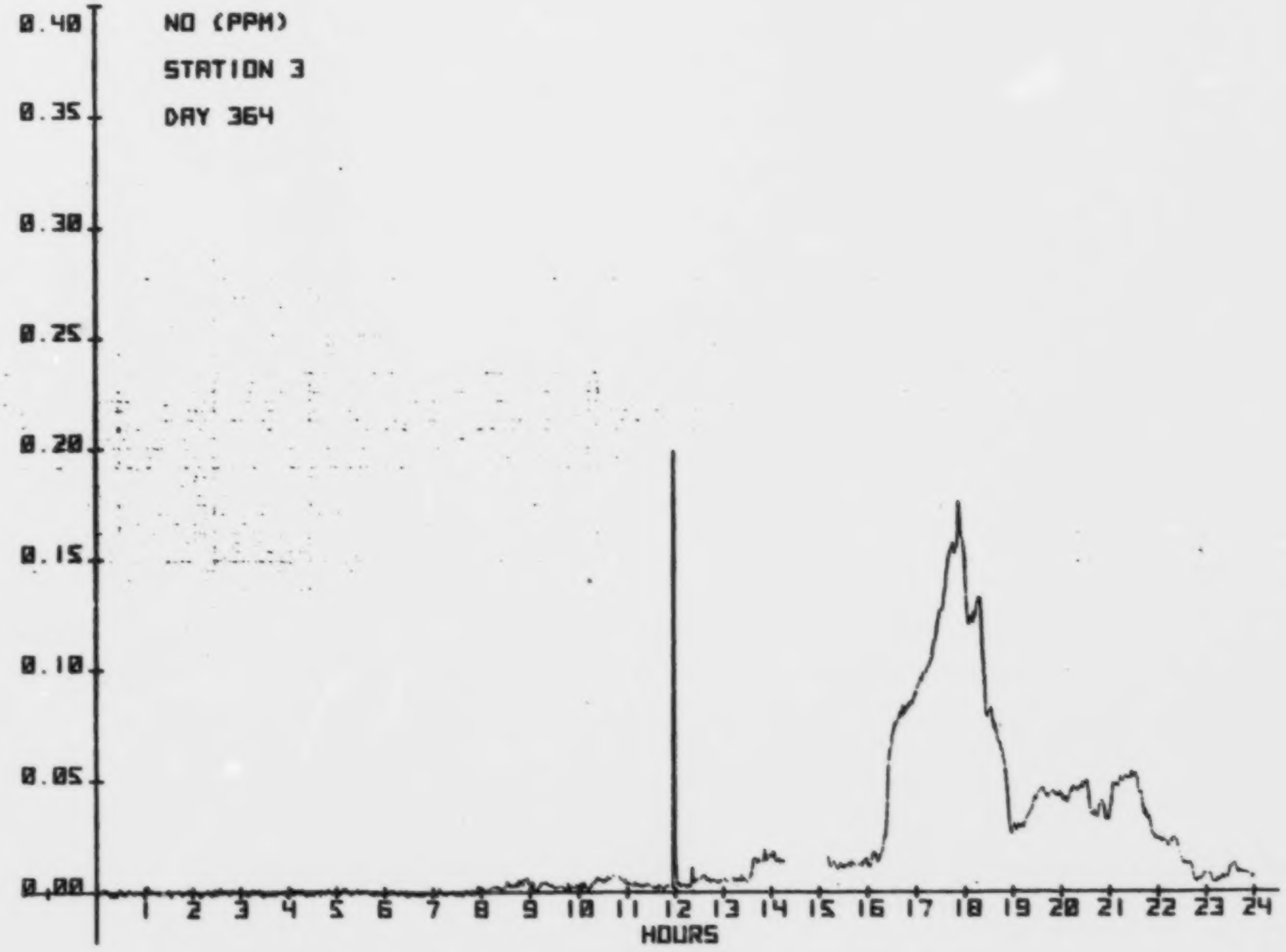

NO (PPM)
STATION 3
DAY 364
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-111.

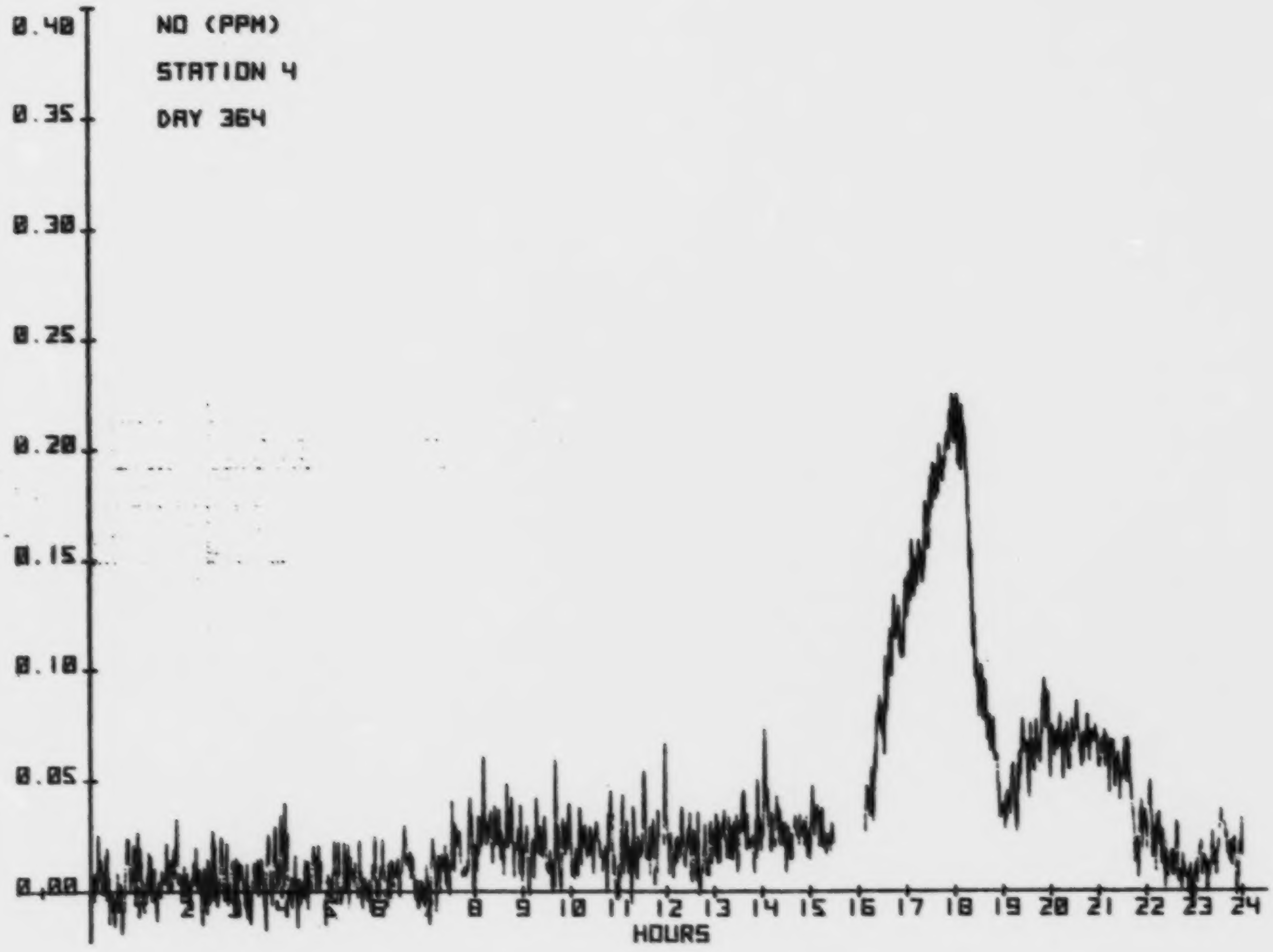

NO (PPM)
STATION 4
DAY 364
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-112.

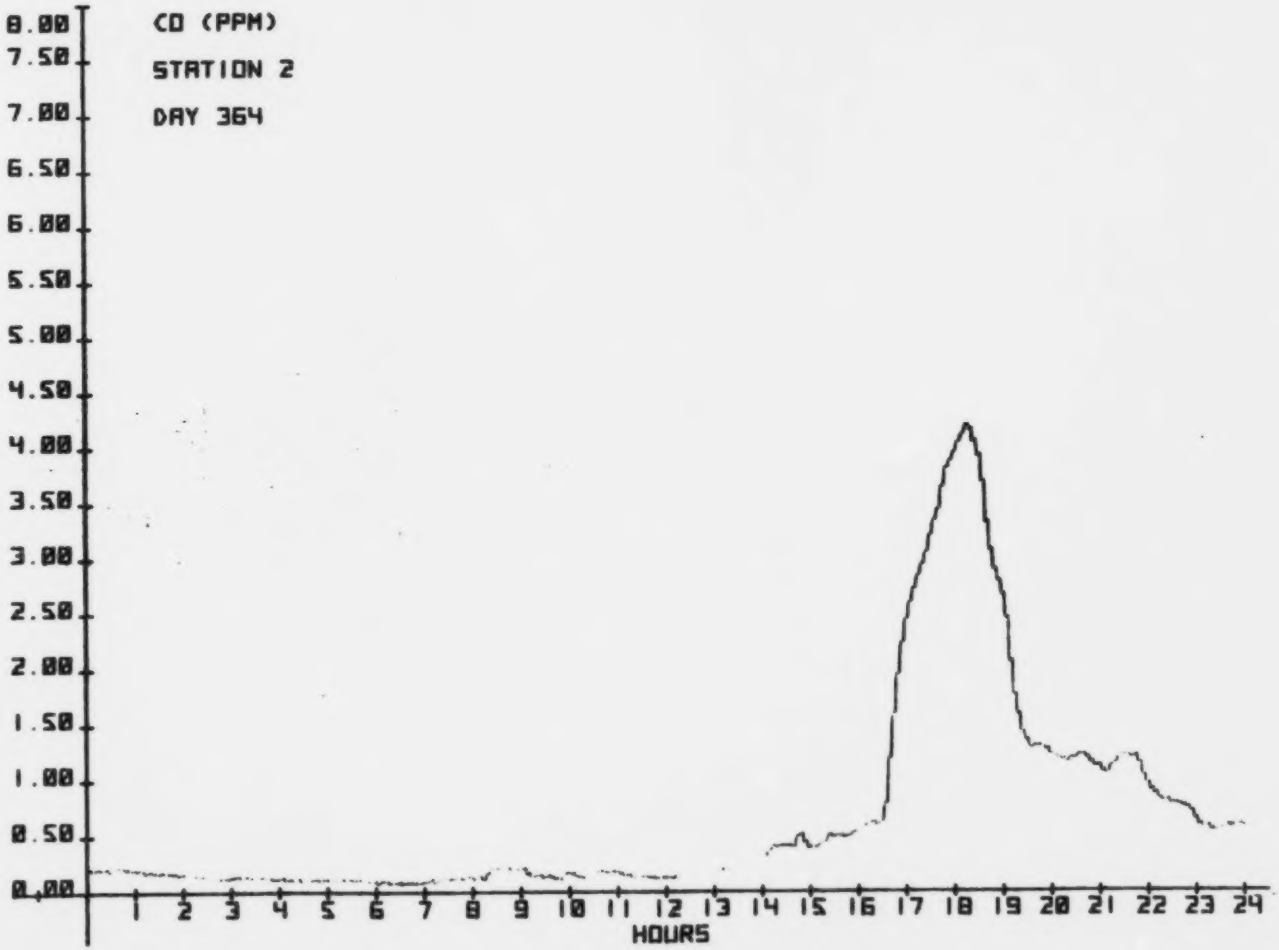

CO (PPM)
STATION 2
DAY 364
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-113.

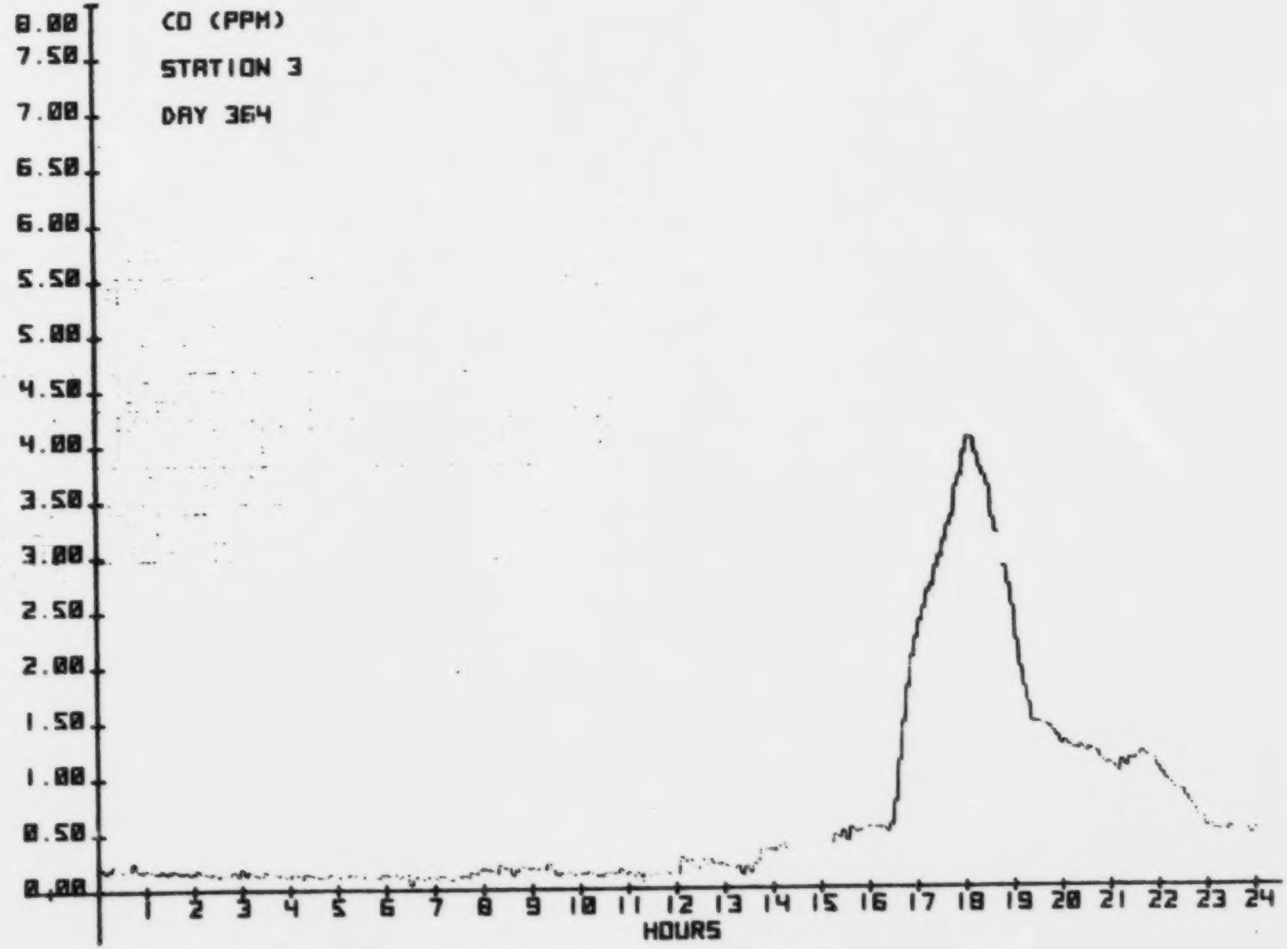

CO (PPM)
STATION 3
DAY 364
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-114.

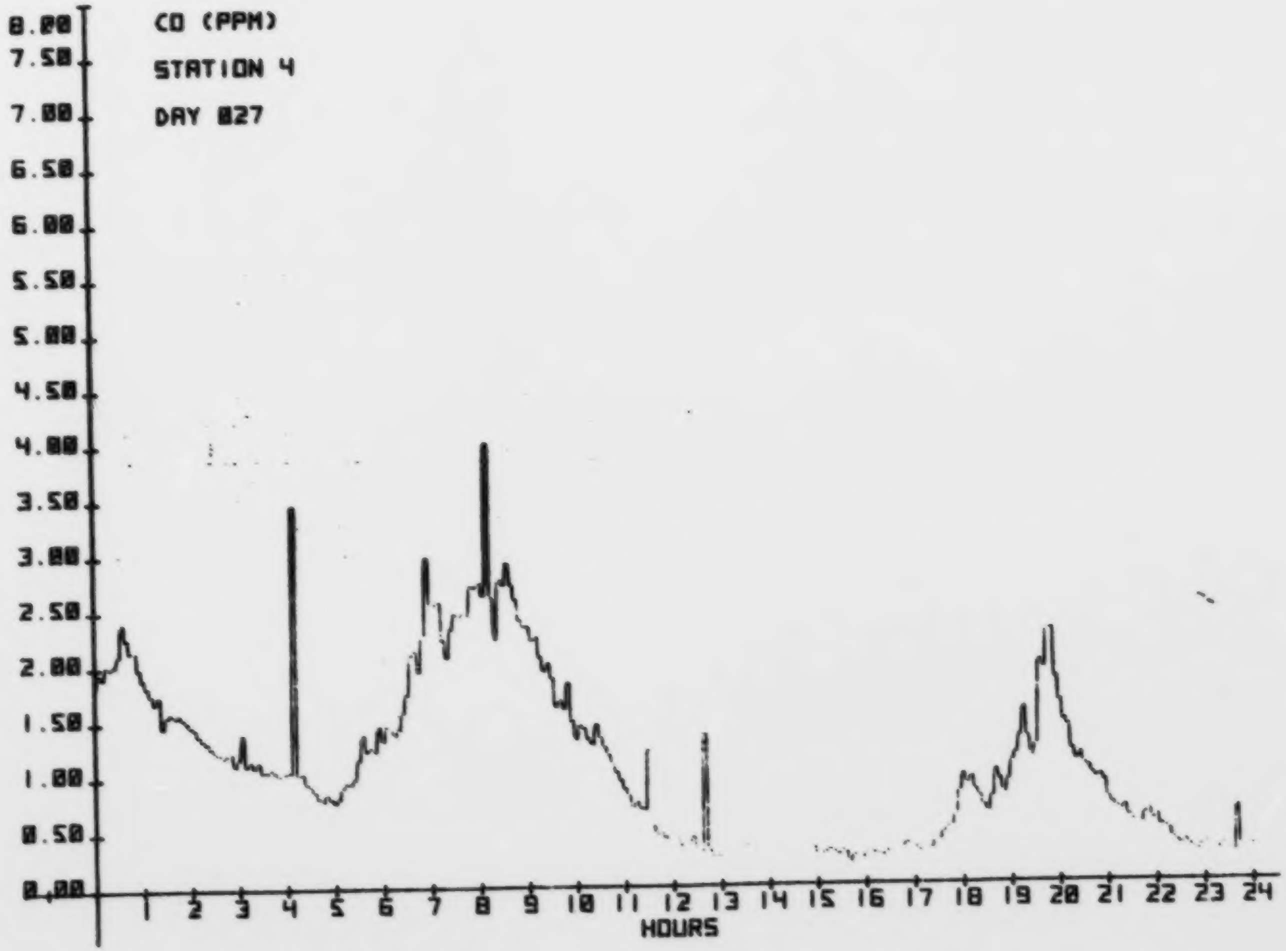

CO (PPM)
STATION 4
DAY 027
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-115.

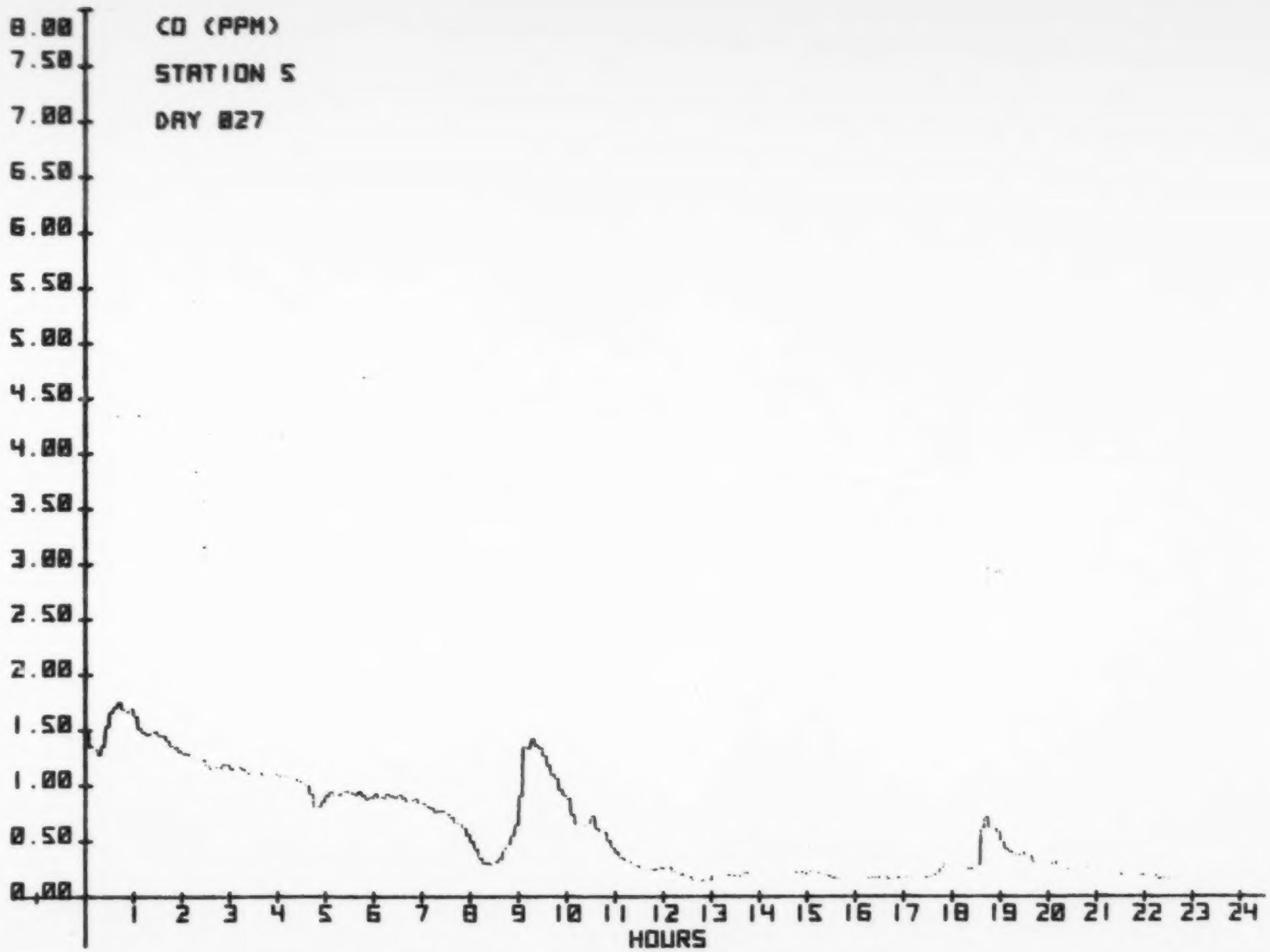

CO (PPM)
STATION 5
DAY 027
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-116.

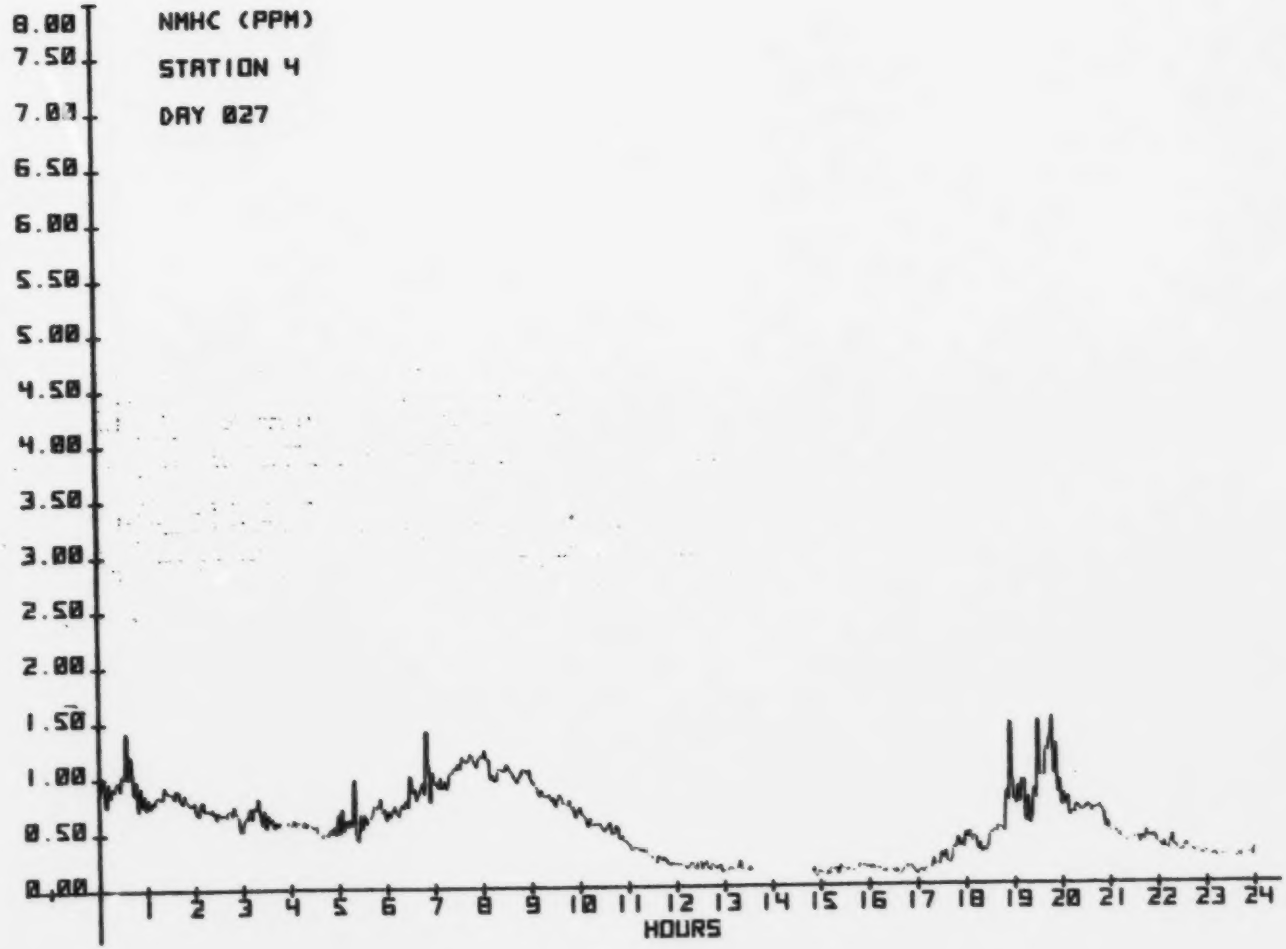

NMHC (PPM)
STATION 4
DAY 027
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-117.

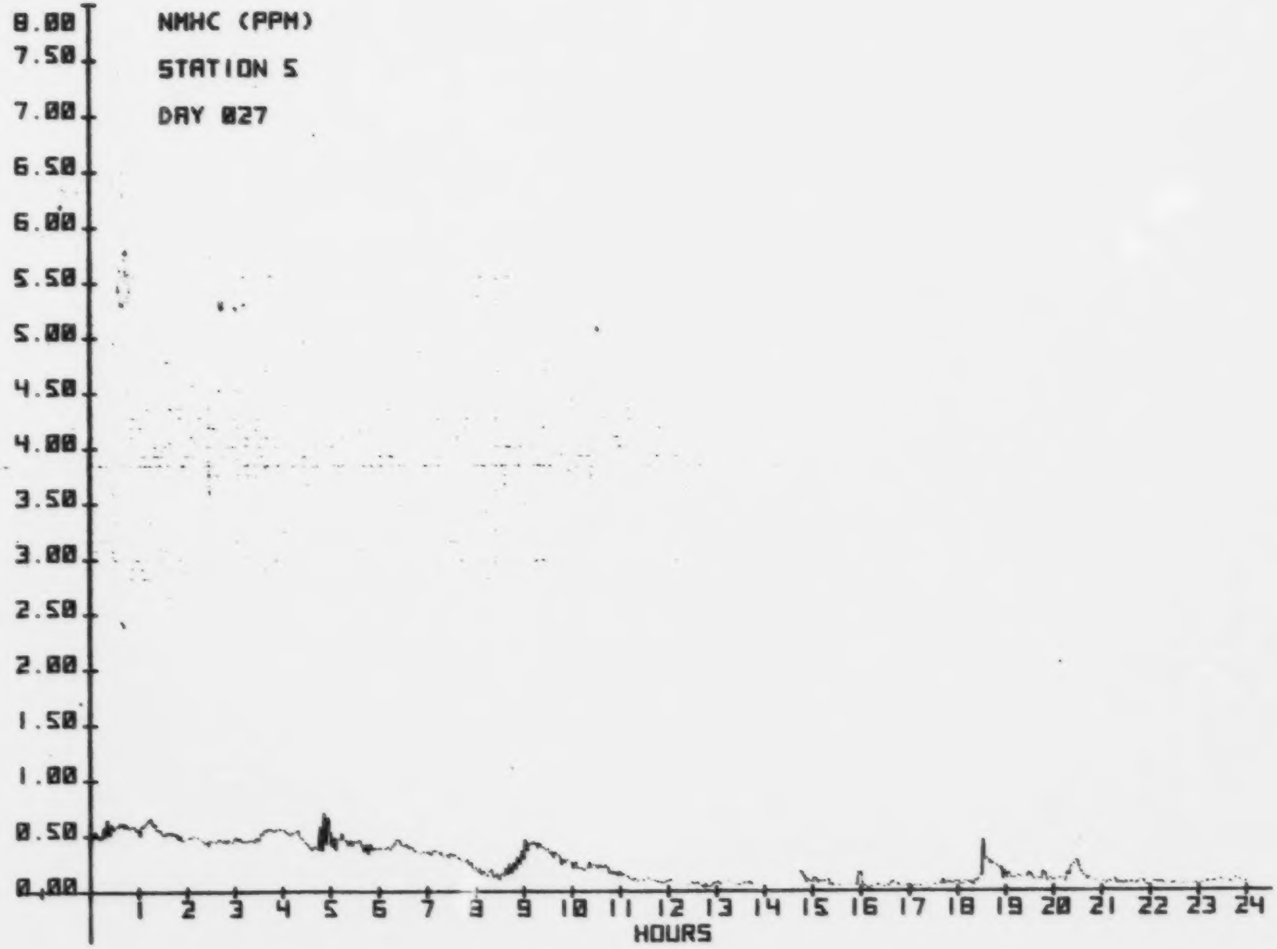

NMHC (PPM)
STATION 5
DAY 027
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-118.

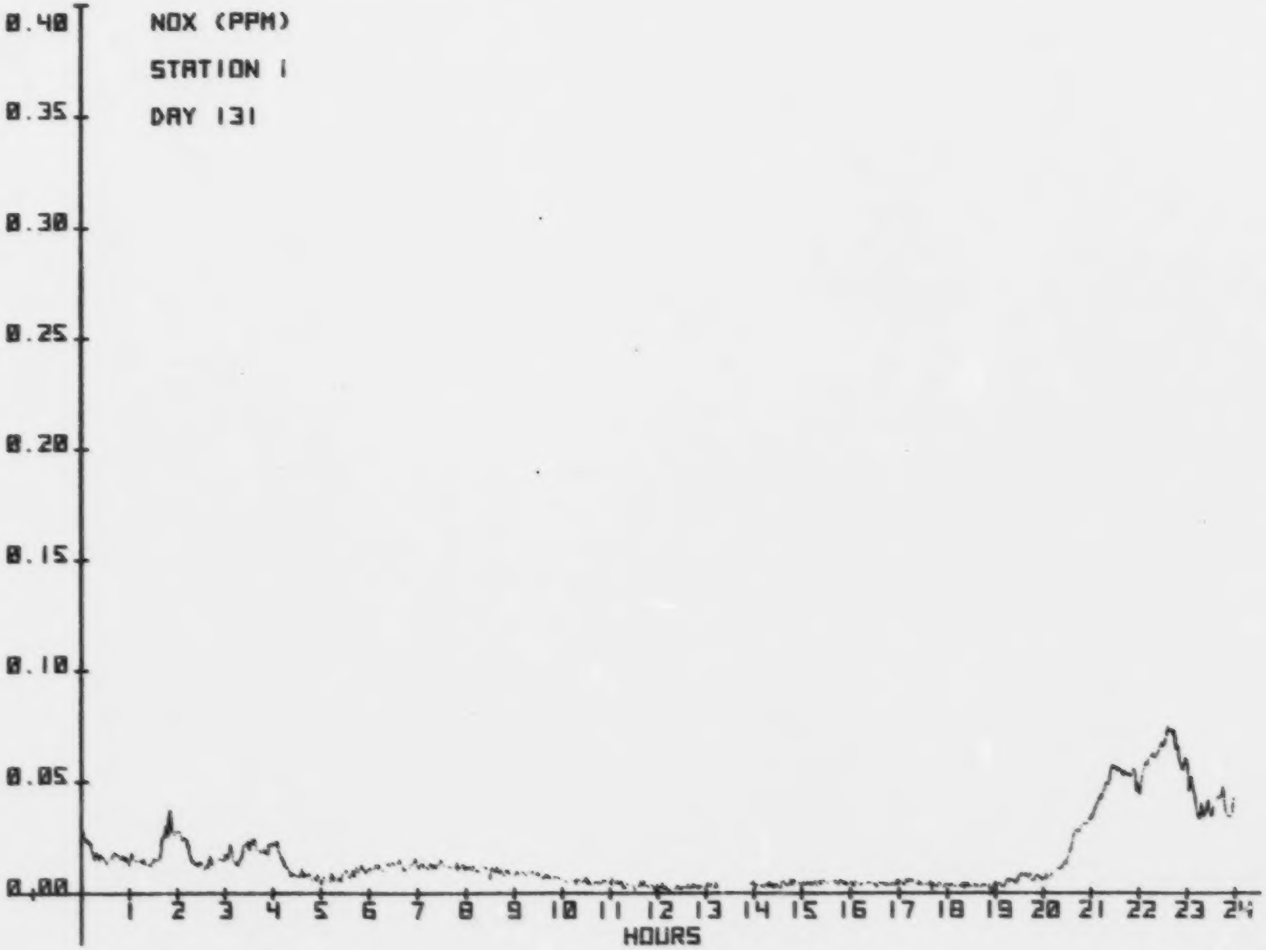

NOX (PPM)
STATION 1
DAY 131
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-119.

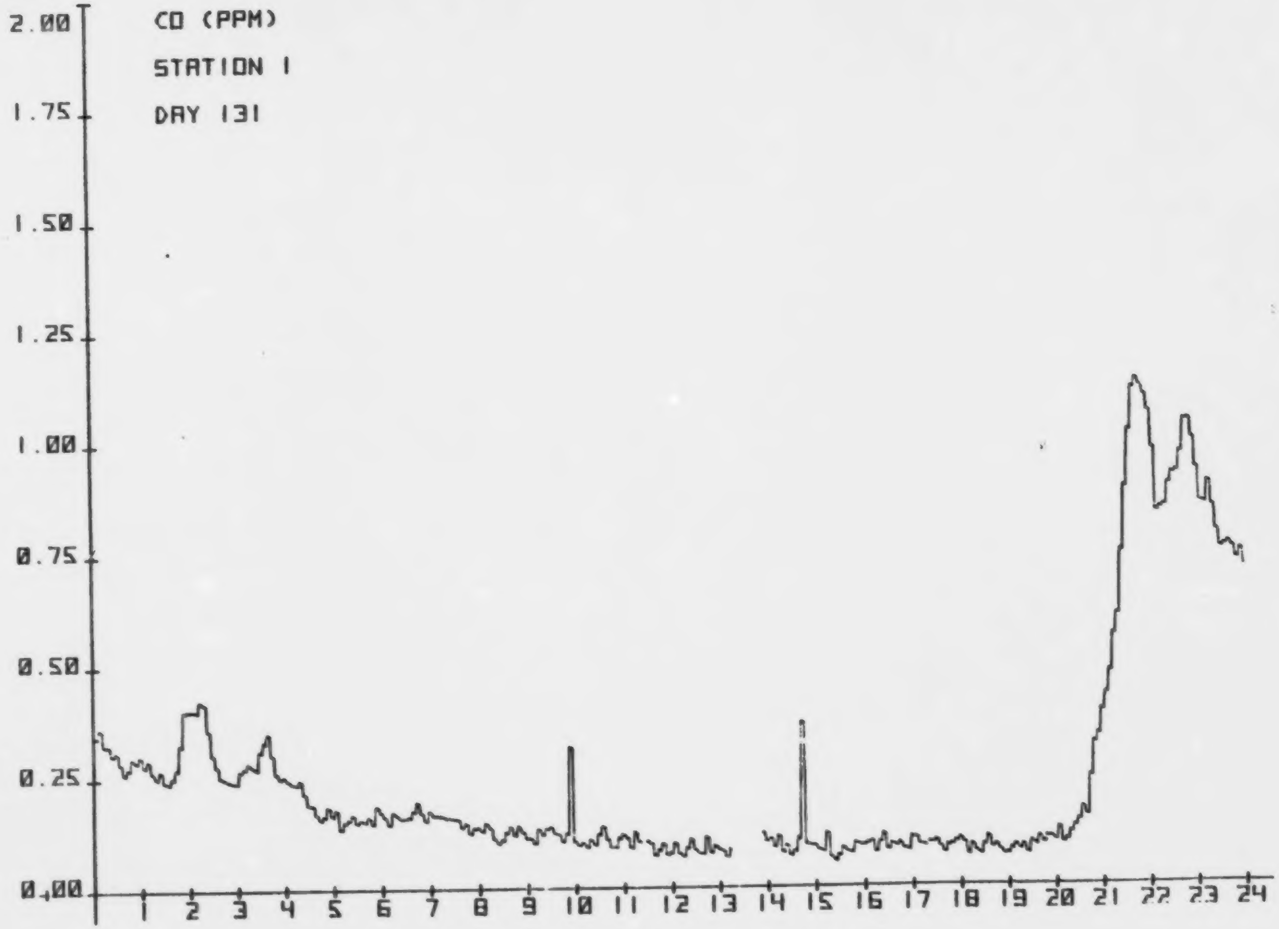

CO (PPM)
STATION 1
DAY 131
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Figure H-120.

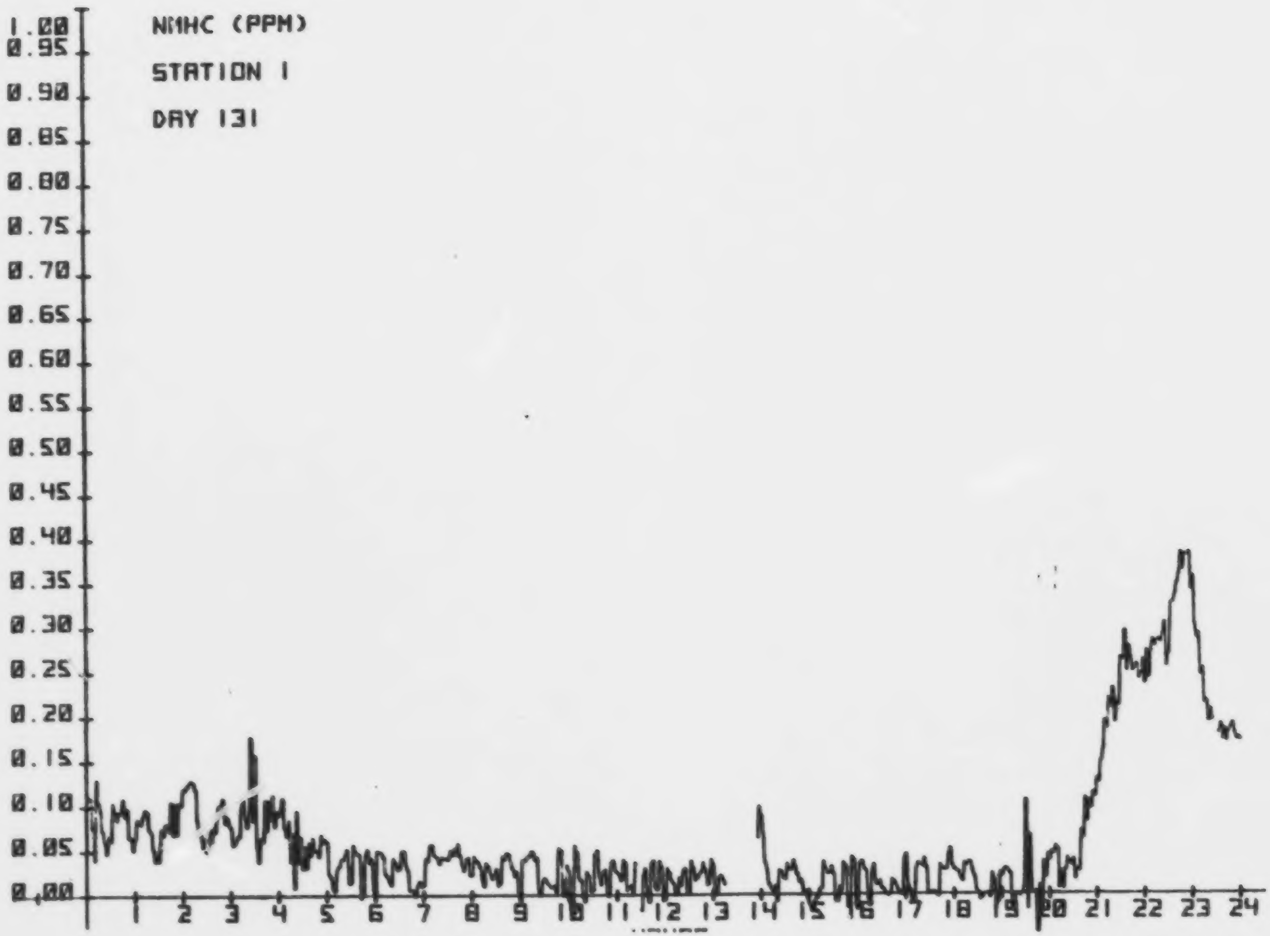

NMHC (PPM)
STATION 1
DAY 131
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Figure H-121.

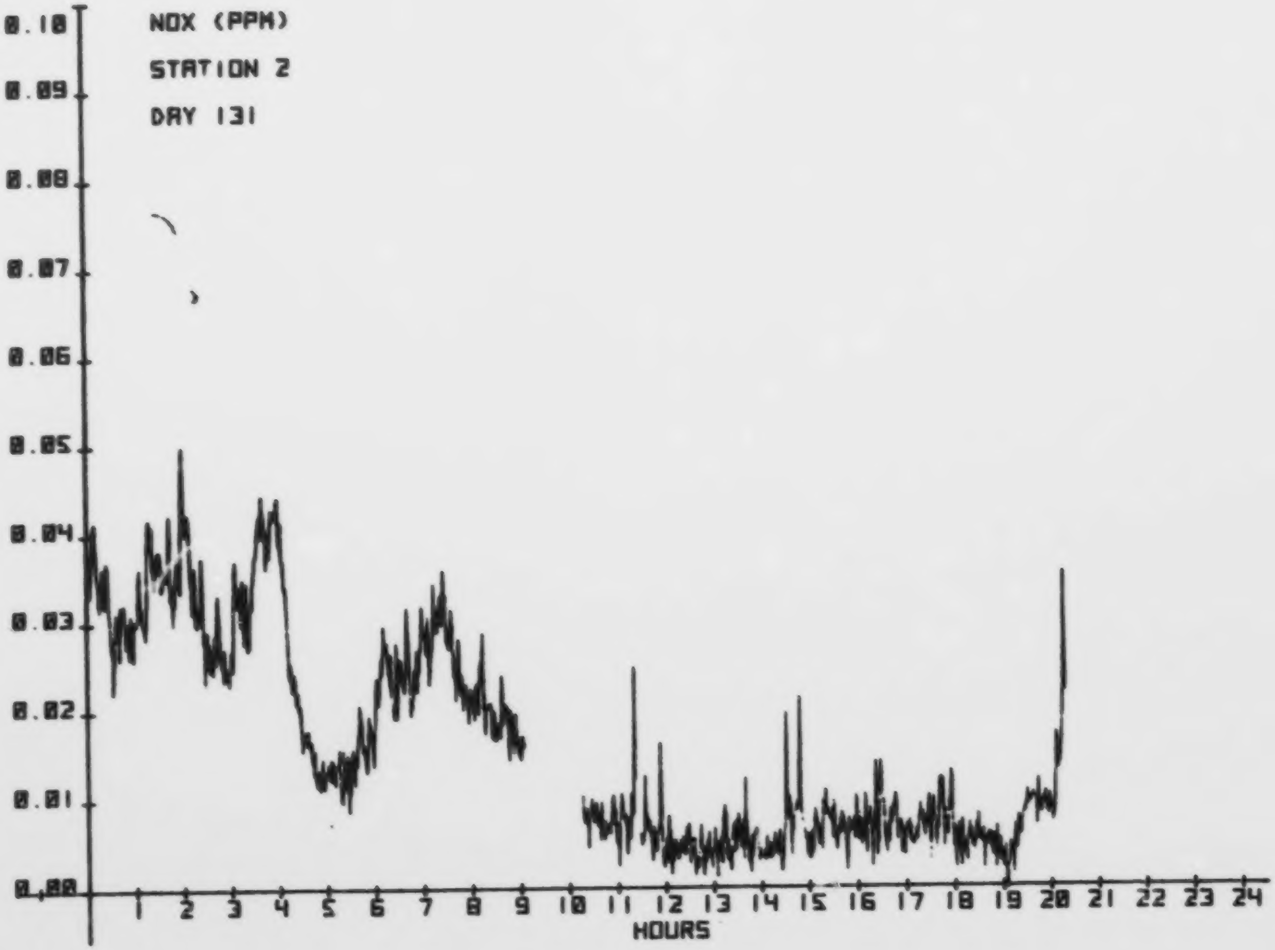

NOX (PPM)
STATION 2
DAY 131
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-122.

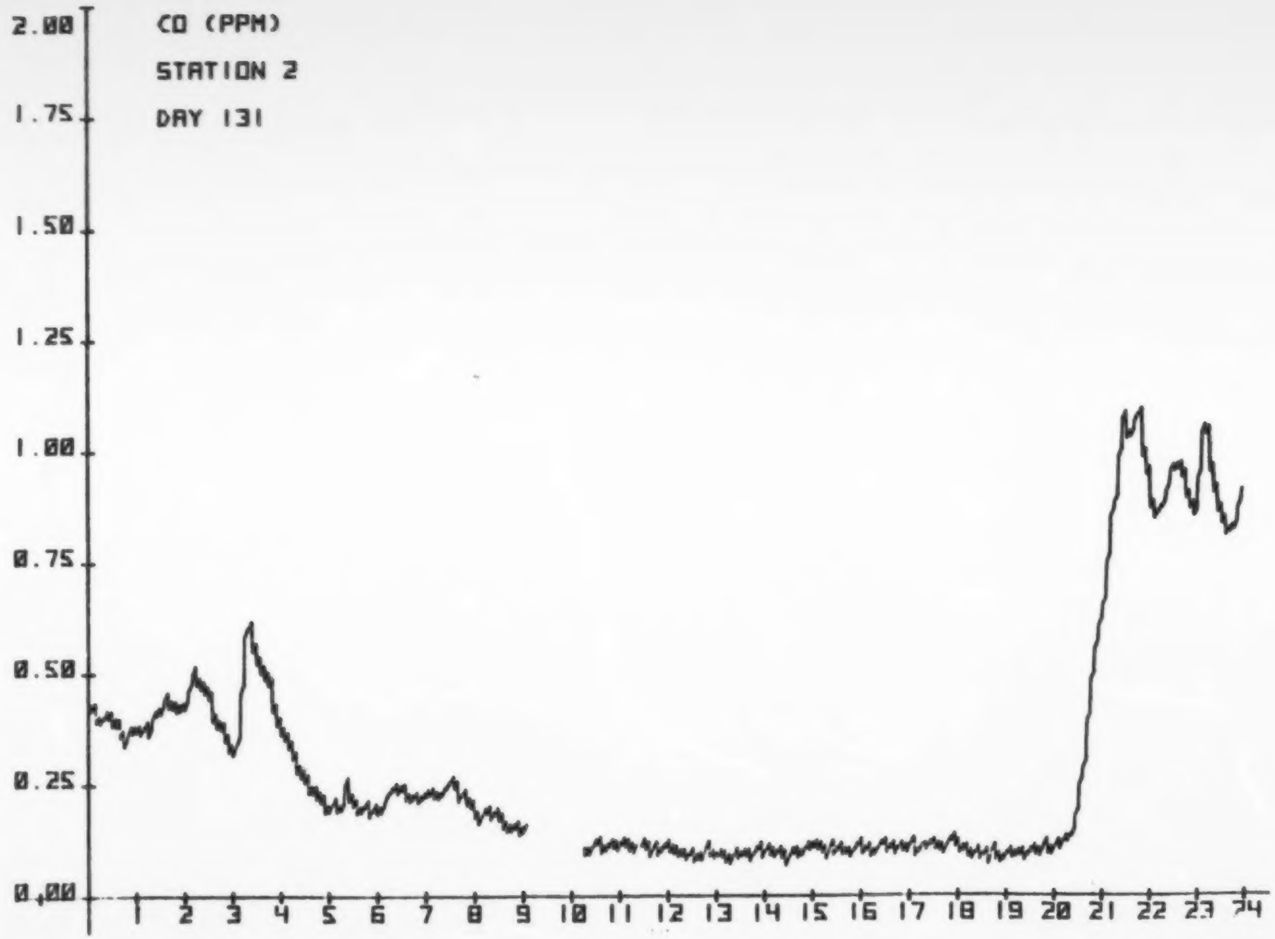

CO (PPM)
STATION 2
DAY 131
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Figure H-123.

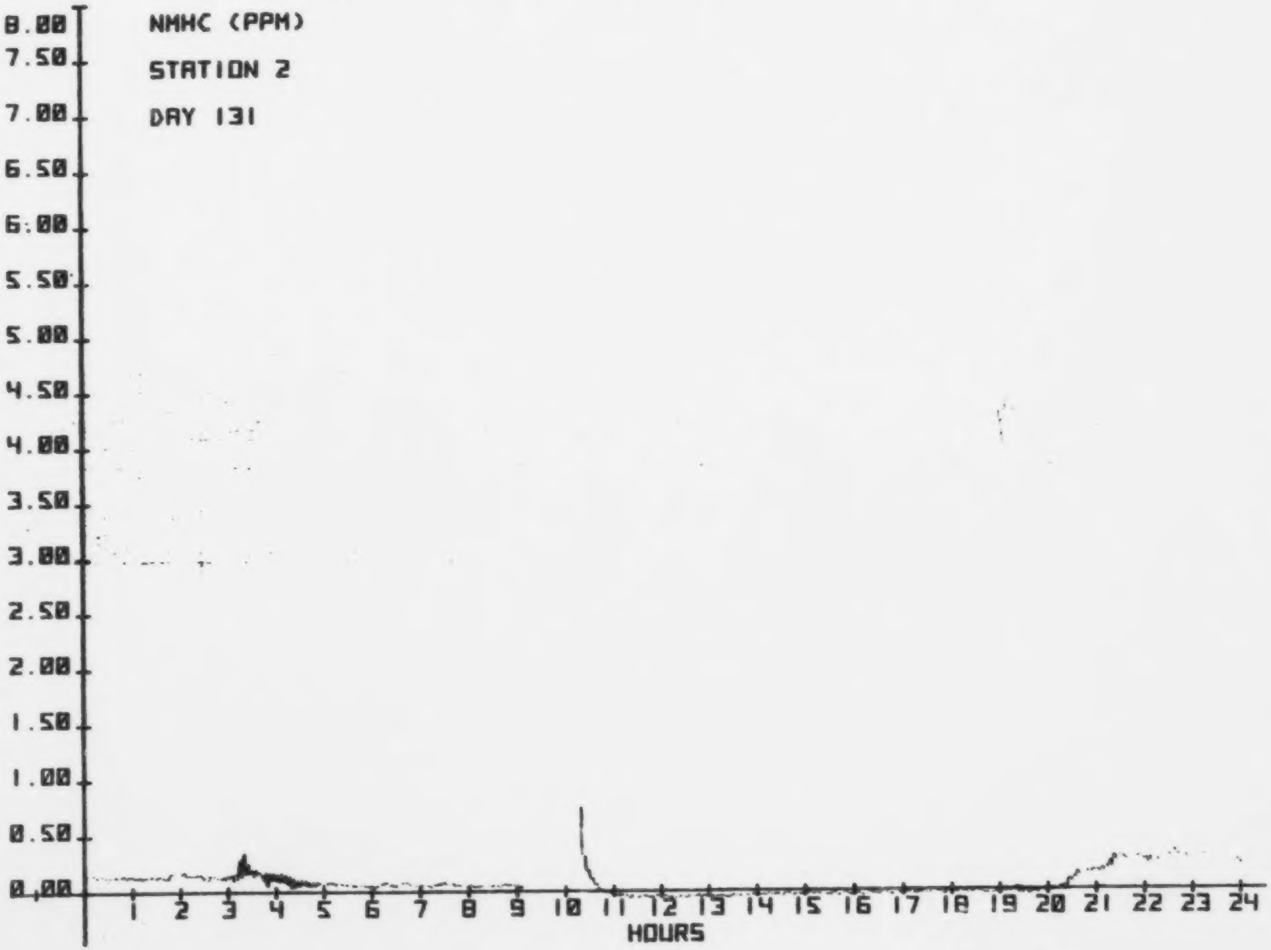

NMHC (PPM)
STATION 2
DAY 131
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-124.

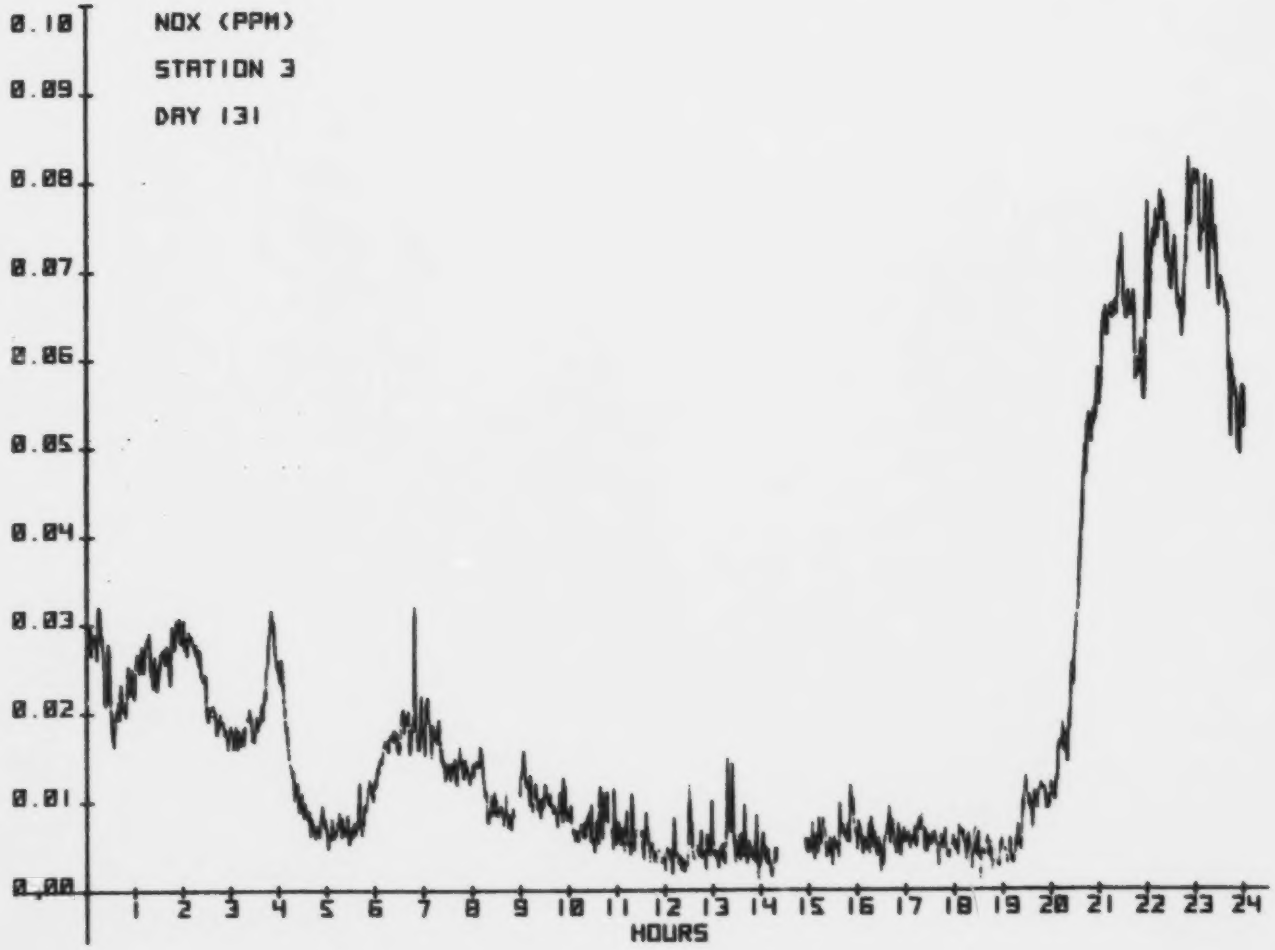

NOX (PPM)
STATION 3
DAY 131
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-125.

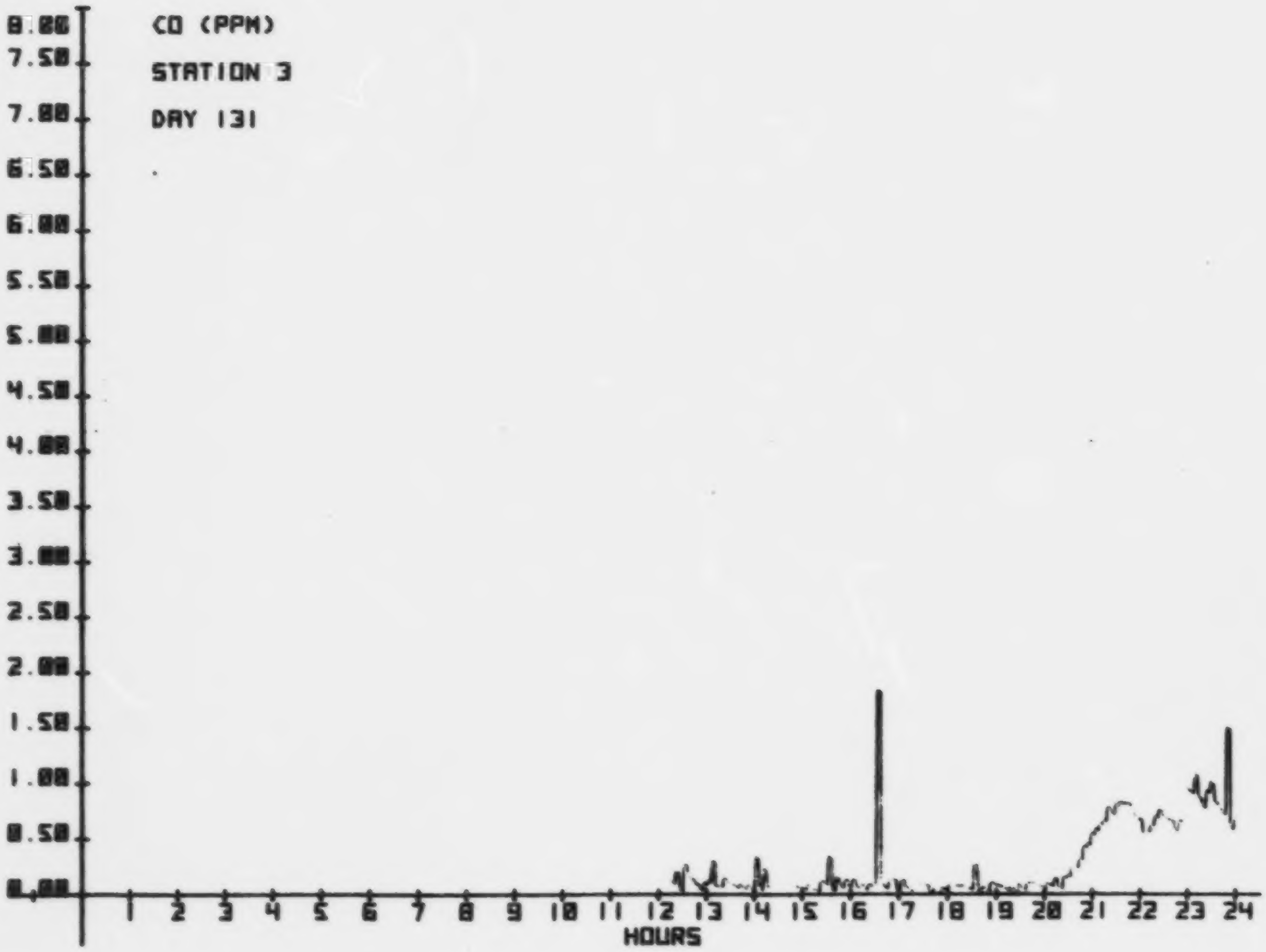

CO (PPM)
STATION 3
DAY 131
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-126.

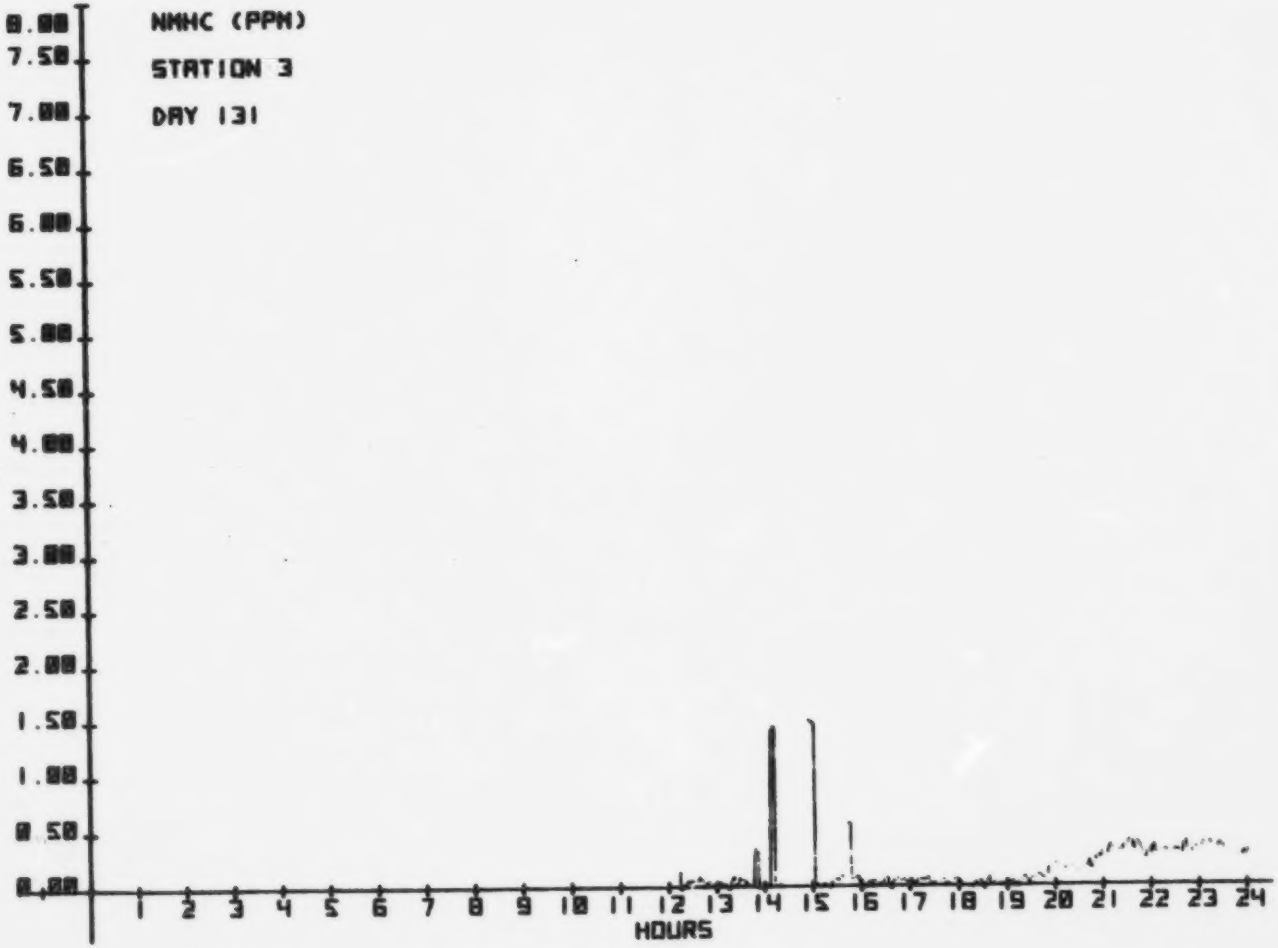

NMHC (PPM)
STATION 3
DAY 131
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-127.

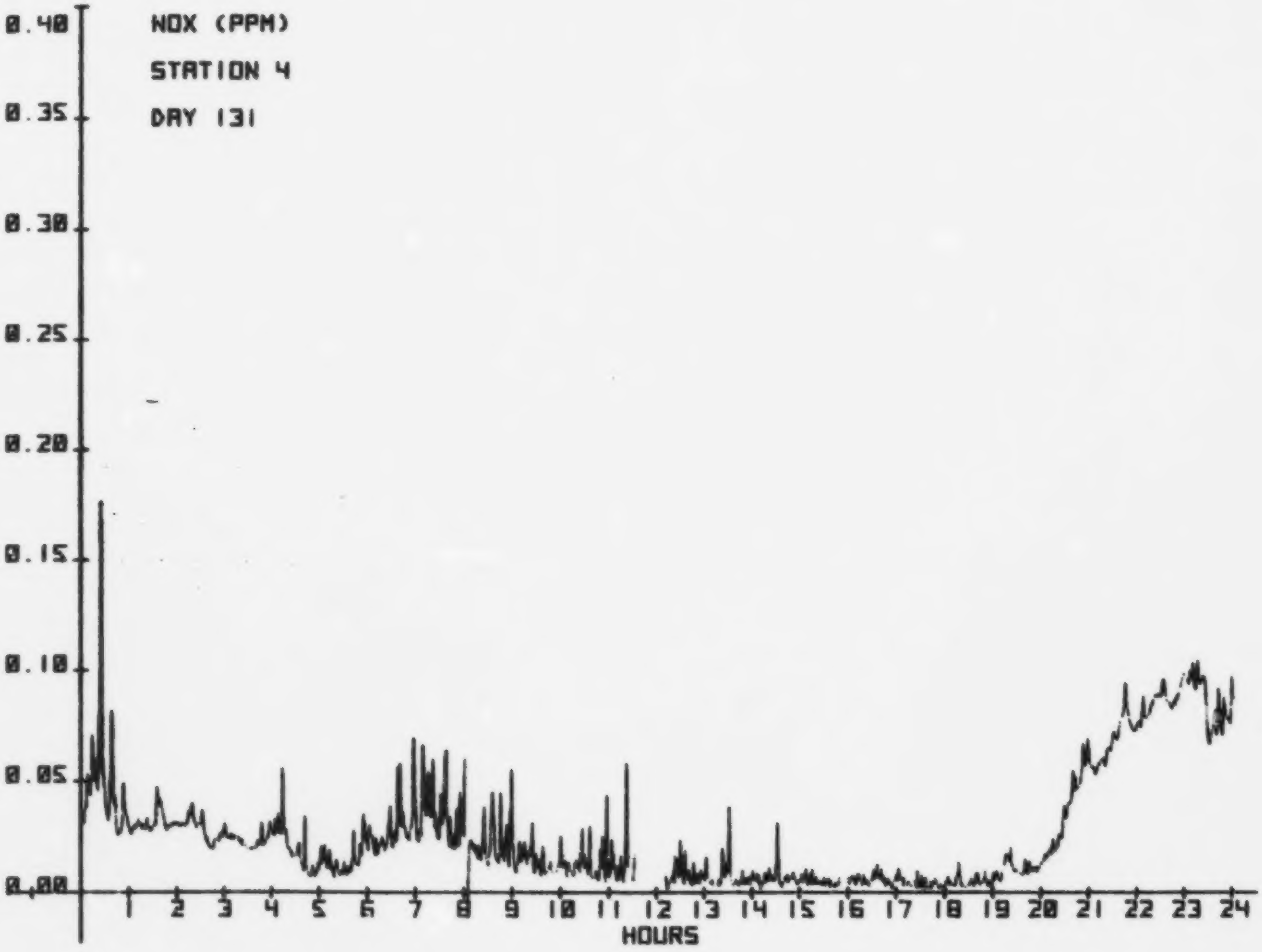

NOX (PPM)
STATION 4
DAY 131
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-128.

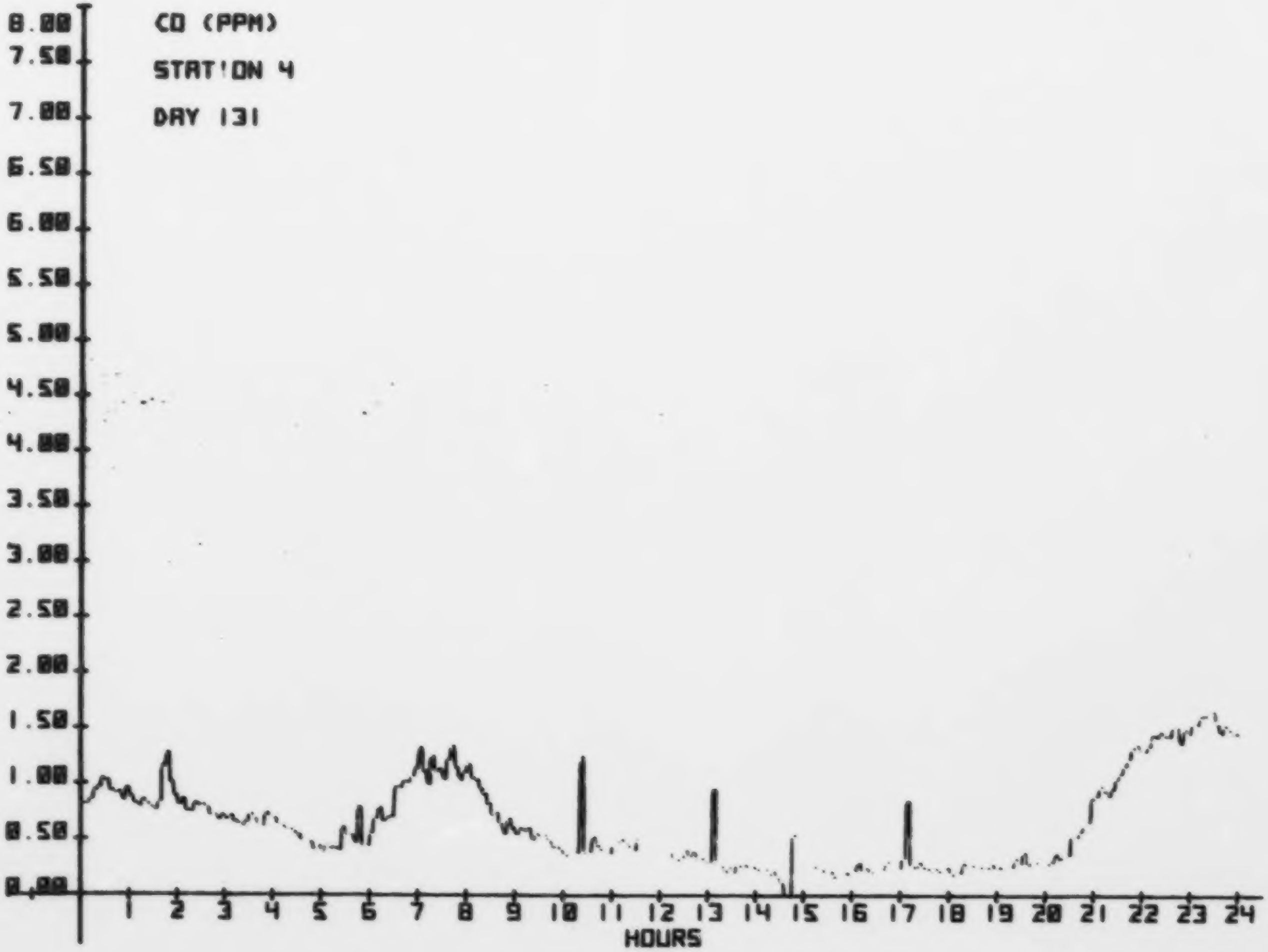

CO (PPM)
STAT'ON 4
DAY 131
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-129.

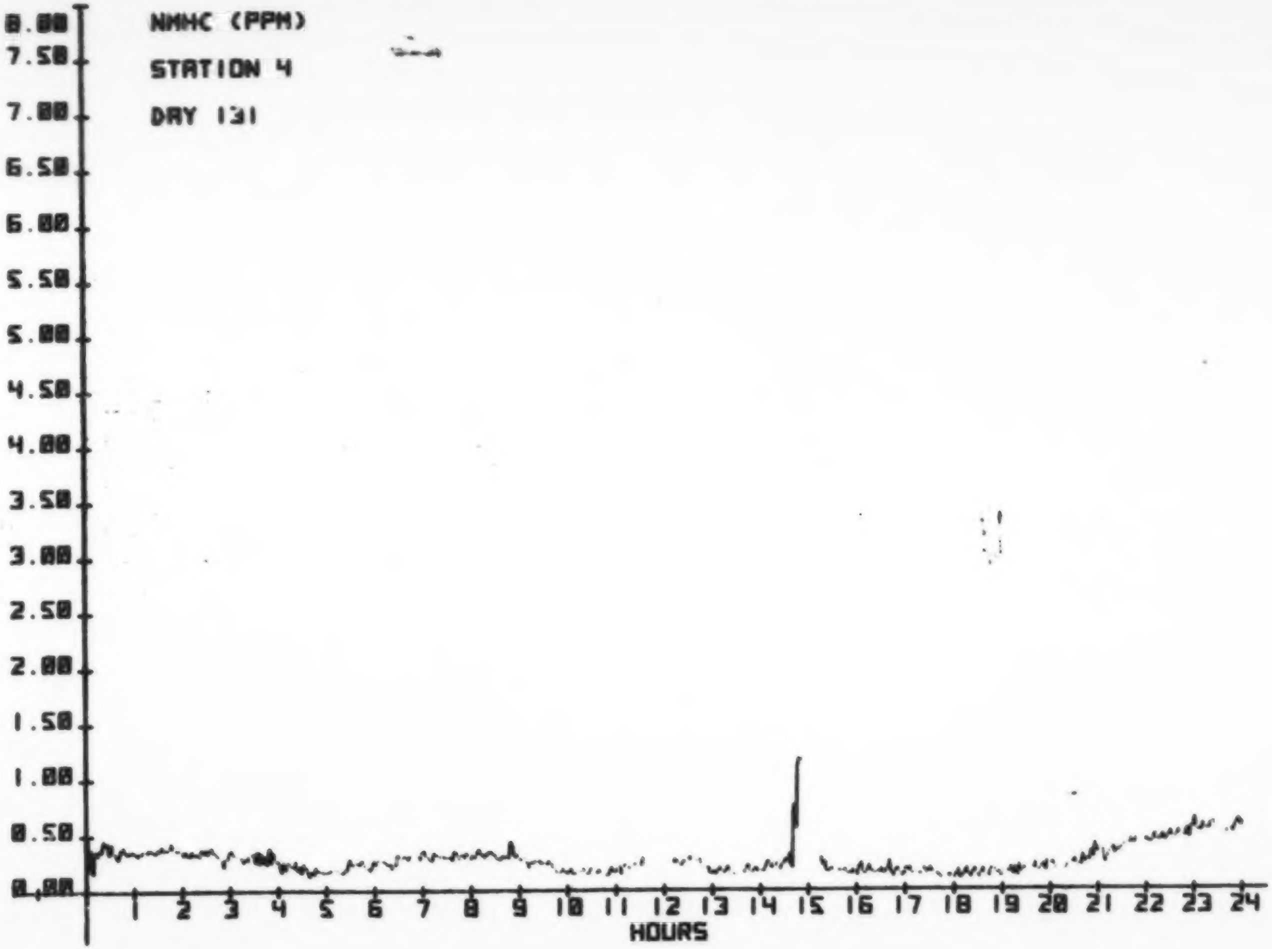

NMHC (PPM)
STATION 4
DAY 131
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-130.

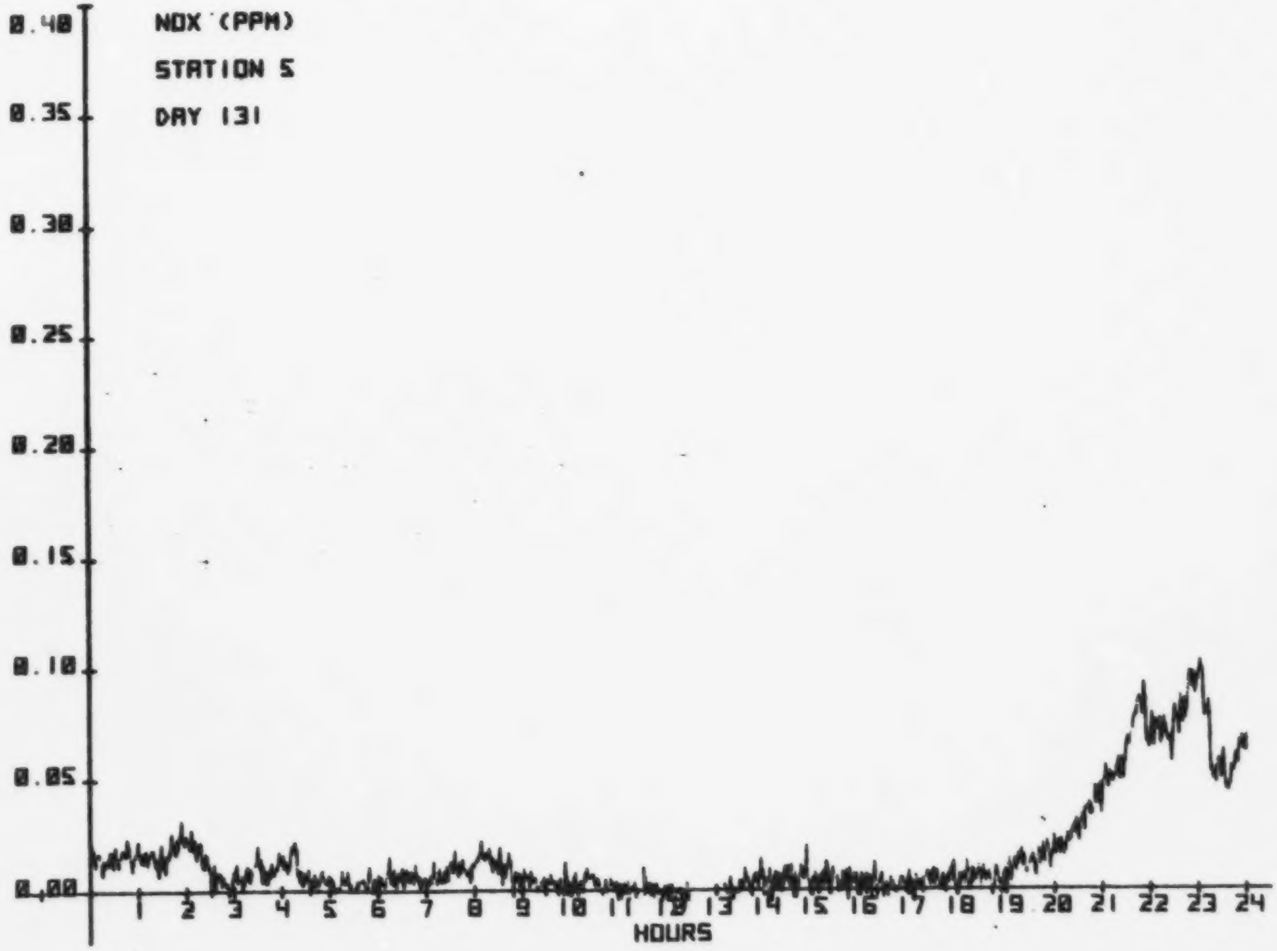
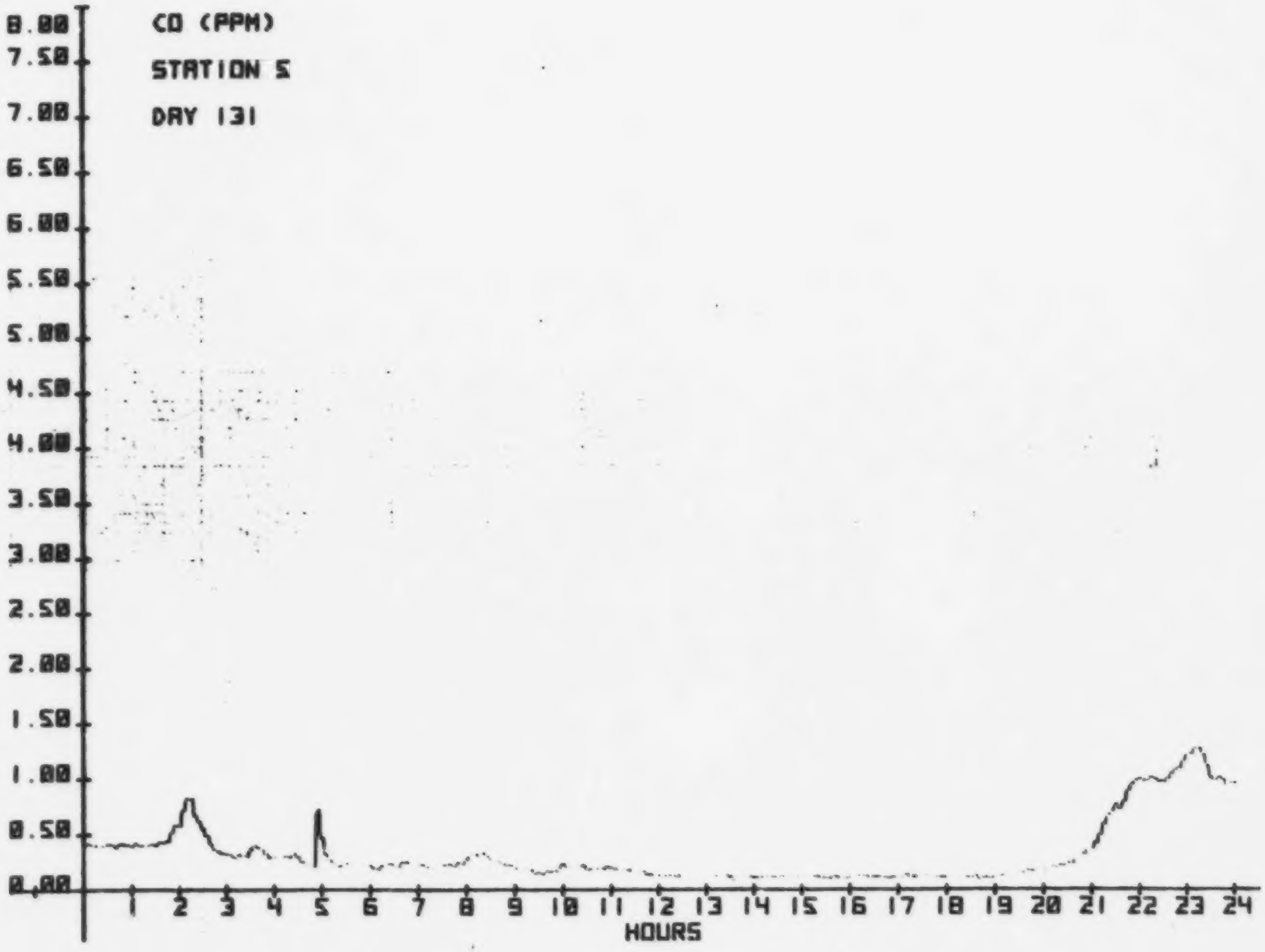

NOX (PPM)
STATION 5
DAY 131
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-131.



CO (PPM)
STATION 5
DAY 131
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

Figure H-132.

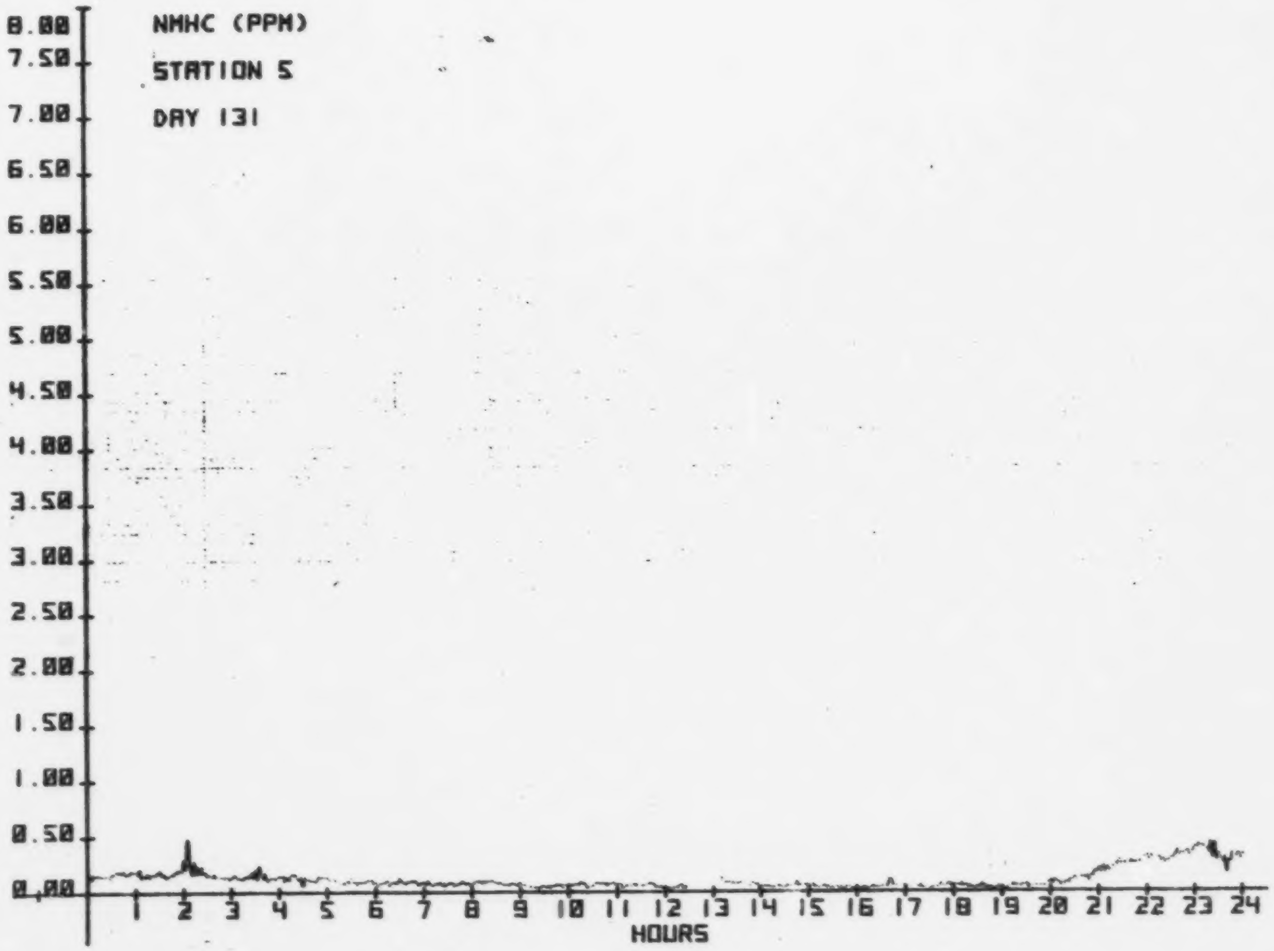

NMHC (PPM)
STATION 5
DAY 131
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HOURS

Figure H-133.

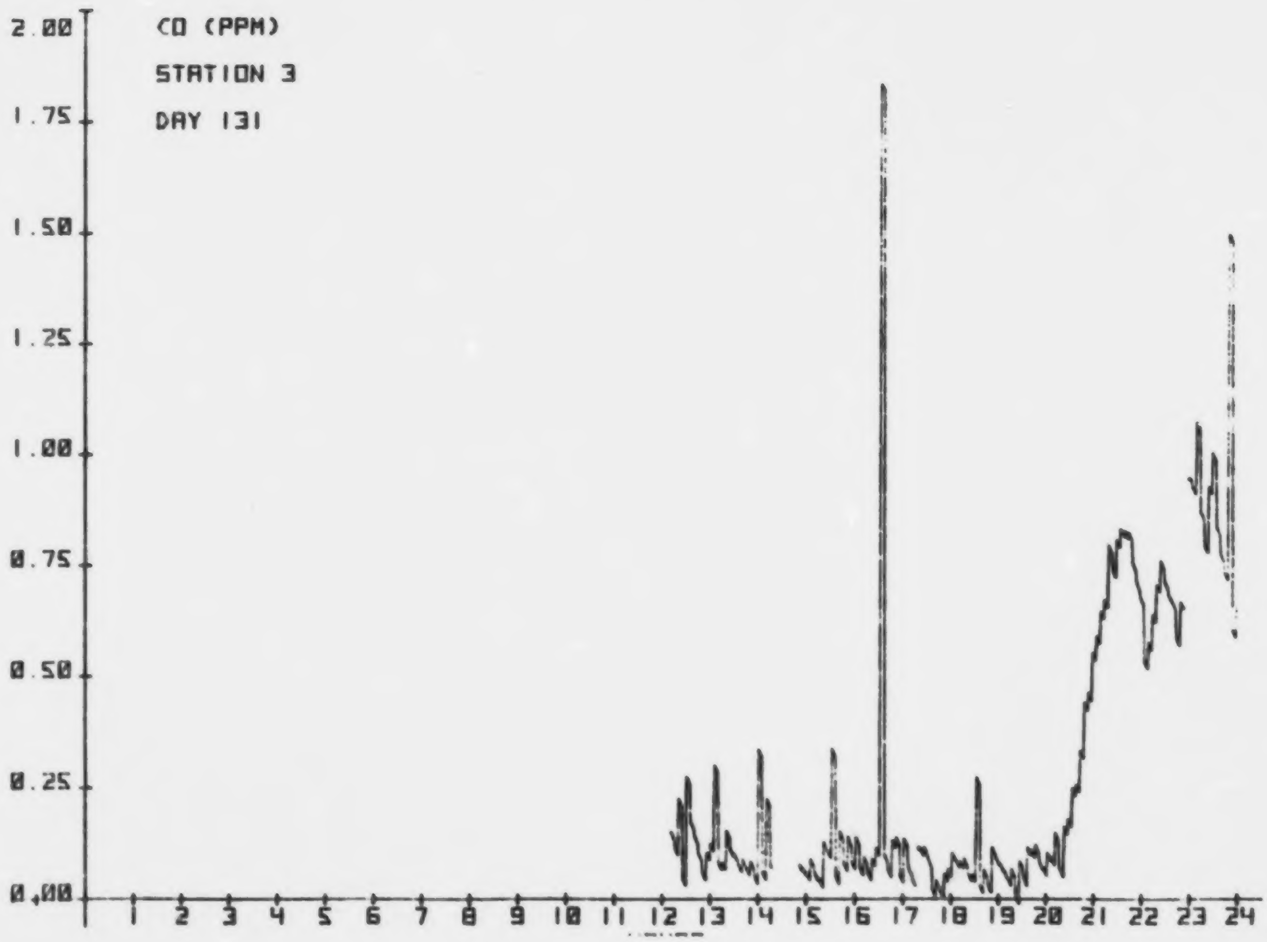

2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
CO (PPM)
STATION 3
DAY 131
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Figure H-134.

APPENDIX I

DATA PROCESSING

Data processing for the WAFB project consisted of the following:

- Handling one-minute data tapes acquired from the air monitoring network (Section 2) and verifying the contents of these tapes (Tape I's)
- Calibrating the one-minute voltage tapes and converting the voltages to engineering units (Tape II's)
- Averaging the one-minute data to produce hourly averages and calculating the root mean square (RMS) average, the standard deviation, and the maximum and minimum for each hour (Tape III's)
- Coding WABAN meteorological data onto computer forms and tape cartridges and merging these data into a data file of consistent format for each month that air quality data were collected (Meteorology Tape)
- Presenting data in the form of tabular listings of hourly data and cumulative frequencies for NO, CO, NMHC, and nephelometer; cumulative frequency distribution of these four parameters; time plots of the hourly averages; time plots of minute values for four Juilian days; and microfiche of the tabular listings
- Compressing 395 Level II tapes concatenated onto a 20-reel set for future analyses

AIR MONITORING NETWORK RAW VOLTAGE TAPES

These tapes contain the raw air quality data voltages and certain meteorological data recorded by the monitoring network and data acquisition system. Because these tapes are the original source of data for all the subsequent processing, they are called Level I tapes or Tape I's. The data on these tapes are unedited and uncorrected and so include the results of instrument calibration, instrument drift, instrument malfunction, and recording errors.

A Tape I was generated for each day of monitoring, resulting in 395 reels of tape for the project. Tape I's were removed from the central data acquisition system at approximately 1100 hours each day. After removal, the tape was mounted on a Cipher 7-track tape unit and printed on a Versatec line printer to provide a permanent record of the data. The line-printer output was also scanned by the air quality engineer for errors in the following categories:

- Instrument operation
- Time of events
- Data coding switch number
- Data transmission

Because the data collection system had no automatic provision for determining instrument failure, the line-printer output was also used as a source of information on system operation.

The characteristics, format, and content of the Level I tapes are given below.

Level I Tapes

Characteristics:

Reels: 7-in (600 ft)
Tracks: 7
Parity: Odd
Density: 556 bits per inch (BPI)
Record Size: Variable (85-132 characters nominal) 116
Code: ASCII

Format and Content: (I3, 3I2, 11I1, 16F6.4)

Character No.:	Information:	
1-3	Day	
4-9	Time (HHMMSS)	
10	Station	
	Thumbwheels as follows:	
11	Empty	
12	NO	
13	NO_x	
14	CH_4	
15	THC	
16	CO	
17	WS	
18	WD	
19	MEPH	
20	No.	
21-26	Channel 0	Empty
27-32	Channel 1	NO

Format and Content: (I3, 3I2, 11I1, 16F6.4)

Character No.:	Information:	
33-38	Channel 2	NO_2
39-44	Channel 3	CH_4
45-50	Channel 4	THC
51-56	Channel 5	CO
57-62	Channel 6	WS
63-68	Channel 7	WD
69-74	Channel 8	NEPH
75-116	Pyranometer, T1, ΔT, T2, u, v, w (for station 4 only)	

TAPE I-TO-TAPE II PROCESSING

The calibrated engineering unit (one-minute) tapes are called Level II tapes or Tape II's. Processing of Tape I data started with the production of a corrected one-minute tape using zero and span check and calibration adjustment information that was recorded by the central data acquisition unit at WAFB. This initial editing of the raw data tapes was accomplished using an HP-9825 calculator, two Cipher Data 7-track tape recorders, two Cipher Data 9-track tape recorders, and HP-9826A digital plotter, and a Versatec LP-D1150 line printer. The Tape I-to-Tape II process is summarized in a flowchart in Figure I-1. A detailed description of the process follows. The 7-track tapes of series I were printed and checked, and calibration data with thumbwheel information were removed. An errata sheet listing necessary corrections and listings to be made was used during this process. The line-printer output of Tape I's was analyzed to determine the condition of the data on each tape.

A program for thumbwheel and calibration data was run on the HP-9825 to retrieve calibration zero and span voltages and thumbwheel codes from the Tape I's. The calibration voltages were printed and inspected for errors which included the following:

- Spurious noise spikes occurring during calibration
- Missing values from the data so that final readings were not obtained. The missing values were generally located on the Tape I printout and added to the list.
- Obviously wrong values caused by improper setting of the data switches
- A series of decreasing values for a "zero" or a series of increasing values for a "span," indicating insufficient time was allowed for stabilization during calibration

Errors in calibration were not corrected when they were caused by the following:

- Improper adjustment of flow rates or overflow rates

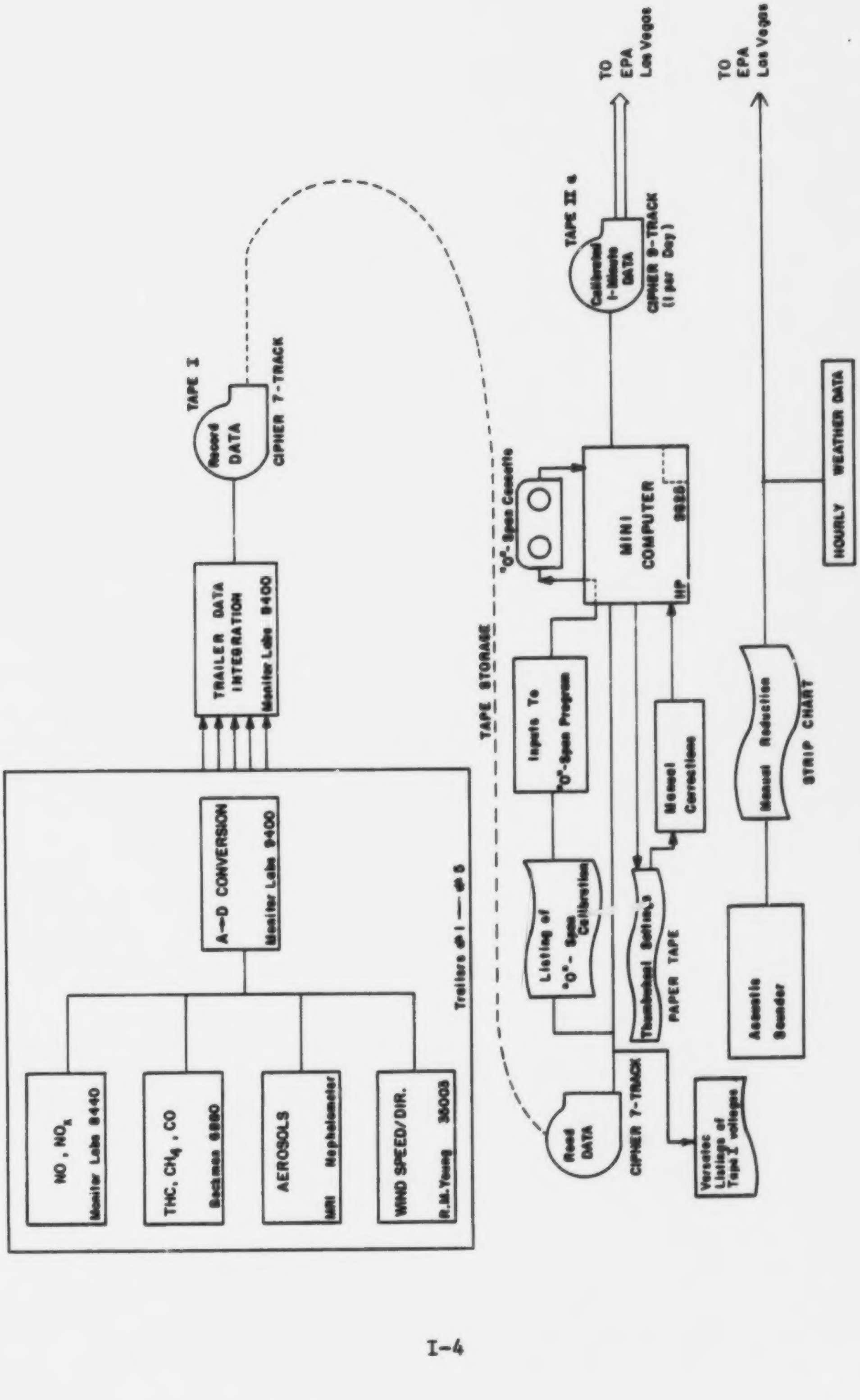

NO, NO_x
Monitor Labs 8440
THC, CH_4, CO
Beckman 6800
AEROSOLS
MRI Nephelometer
WIND SPEED/DIR.
R.M.Young 35003
Trailers #1 — #5
A—D CONVERSION
Monitor Labs 9400
TRAILER DATA INTEGRATION
Monitor Labs 9400
Record DATA
TAPE I
CIPHER 7-TRACK
TAPE STORAGE
Read DATA
CIPHER 7-TRACK
Versatec Listings of Tape I voltages
Listing of "0"- Span Calibration
Thumbwheel Settings
PAPER TAPE
Inputs To "0"-Span Program
Manual Corrections
"0"- Span Cassette
MINI COMPUTER
HP 9830
Calibrated 1-Minute DATA
TAPE II s
CIPHER 9-TRACK (1 per Day)
TO EPA Las Vegas
Acoustic Sounder
Manual Reduction
STRIP CHART
HOURLY WEATHER DATA
TO EPA Las Vegas

Figure I-1. Flowchart for WAFB data acquisition and processing.

- Not allowing sufficient time for an instrument to span or zero
- Instrument malfunction
- Improper setting of range switches or time constants. Occasionally an attempt was made to correct a bad value if instrument operating history allowed the evaluation of zero and span values before and after any questionable value. If a reliable calibration value could not be obtained, corrections were made to the next valid value, and the questionable calibration value was discarded.

The calibration values were put into a correction array (see Correction Program) and stored on HP-9825 tape cartridges. Calibration was begun by writing a calibration card, which was checked and typed into the correction array, for an edit program specific for each day of monitoring from June 1, 1976, thorugh June 30, 1977. Major steps in this process are listed below.

- The raw data tape series was read on the HP-9825 record.
- Calibration values for adjustment and zero and span were averaged and printed.
- Voltage data were converted to air quality concentrations and engineering units (see equations 1-3 below).
- Uncorrectable data were replaced with 9's on the Tape II's.

Tape II series were recorded on 9-track magnetic tape.

The conversion of voltage units to concentration and engineering units was made using the following equations:

For NO-NO$_x$: (Eq. 1)

$$\text{ppm} = \left[V_i - V_{01} + T_i \frac{V_{01} - V_{02}}{T_2 - T_1}\right] \left(\frac{C}{V_1 - V_{01}}\right) \left[1 + T_i \frac{(V_1 - V_{01}) - (V_2 - V_{02})}{(T_2 - T_1)\ (V_2 - V_{02})}\right]$$

For CH$_4$, THC, and CO:

$$\text{ppm} = V_i \left(\frac{C}{V_1}\right) \left[1 + T_i \frac{V_1 - V_2}{(T_2 - T_1)(V_2)}\right] \qquad \text{(Eq. 2)}$$

For the nephelometer*:

$$b_{scat} = \left[V_i - (V_{PA1} - .09) - T_i \frac{V_{PA1} - V_{PA2}}{T_2 - T_1}\right]\left(\frac{\text{Freon b}}{V_{FR}}\right)\left(\frac{V_1 - V_{PA1} + .09}{V_2 - V_{PA2} + .09}\right) \tag{Eq. 3}$$

$$\left(1 + T_i \frac{(V_1 - V_{PA1} + .09) - (V_2 - P_{PA2} + .09)}{(T_2 - T_1)(V_2 - V_{PA2} + .09)}\right)\left(10^{-4} m^{-1}\right)$$

where

V_i	is the instantaneous voltage at time T_i, which is the time in minutes from the beginning of the previous calibration
V_1	is the initial span voltage in volts
V_2	is the final span voltage in volts
V_{01}	is the initial zero voltage in volts
V_{02}	is the final zero voltage in volts
C	is the span gas concentration in parts per million
T_1	is the time for the initial zero and span in minutes from the time of last calibration
T_2	is the time for the final zero and span in minutes from the beginning of the year
V_{PA1}	is the calibration pure air span in volts
V_{PA2}	is the corrected pure air span in volts
Freon b	is the span standard of Freon 12, CCl_2F_2,
V_{FR}	is the Freon calibration voltage in volts

The result of these four steps was a calibrated engineering-units tape of minute values for each raw voltage tape (Level I) produced at WAFB. These Level II tapes have the following characteristics and format.

[* Note: Pure air has a $b_{scat} = 0.09$ V or 0.23×10^{-4} m^{-1}.]

Characteristics:

Reels:	14-in (2400 ft)
Tracks:	9
Density:	1600 BPI
Parity:	Odd
Record Size:	100 characters
Code:	ASCII
Blocking Factor:	50

Format:

The tapes are unlabeled. Each record is followed by an interrecord gap (IRG) with a minimum length of 19 mm of blank tape.

Character No.:	Information:
1-3	Julian day
4-5	Hour
6-7	Minute
8-9	Second
10	Trailer number
11	Spare
12	NO
13	NO_x
14	CH_4
15	THC
16	CO
17	WS
18	WD
19	NEPH
20	
21-28	NO
29	
30-36	NO_x
37-44	CH_4
46-52	THC
54-60	CO
62-68	WS[a]
70-76	WD[b]
78-84	NEPH
86-92	PSP Pyranometer (station 4 only)
93-100	Temperature station 4

[a] value x 10 = m/s

[b] value x 100 = degrees

TAPE II-TO-III PROCESSING

Hourly average tapes are called Level III tapes of Tape III's. Each tape II was read through the HP-9825A calculator to total the number of air quality concentrations for each interval of 30 minutes before and 30 minutes after the hour during the monitoring period. Concentrations were read as valid data points only if they fell between the acceptable high and low limits of concentration for each air quality parameter. These limits (for NO, NO_x, CH_4, THC, CO, and NEPH) were set after a series of adjustments and additions to the monitoring operations instrumentation at the beginning of the study had established the limits that the instrumentation was capable of measuring.

Hourly averages were calculated if the number of valid one-minute data points for a component in an hour was 30 or more. If the number of valid data points was less than 30 for a given hour, the hourly average was replaced by 9's.

The hourly average value, minimum and maximum concentration, root mean square, and standard deviation were calculated on the half hour for each air quality parameter. A simplified flowchart of the process that produced the one-hour averages (designated Tape III series) is in Figure I-2).

The following steps were taken in the production of Tape III's:

- Read the Level II tapes, calculate an hourly average, root mean square, standard deviation, maximum, and minimum. Store this information on a 9-track tape, one tape for each month of data.
- Plot the hourly averages generated in step 1 and evaluate the plots for spurious values.
- Read the 9-track tapes into the DOE CDC-6400 computer and edit out spurious values.
- Make a list of averages that were edited out.
- Write the final Tape III on 9-track tape.

Thirteen Tape III's were generated. Each tape contains one-month of hourly data. Copies have been sent to ANL, and a copy has been retained in Las Vegas. The following parameters were utilized during production of the Tape III's.

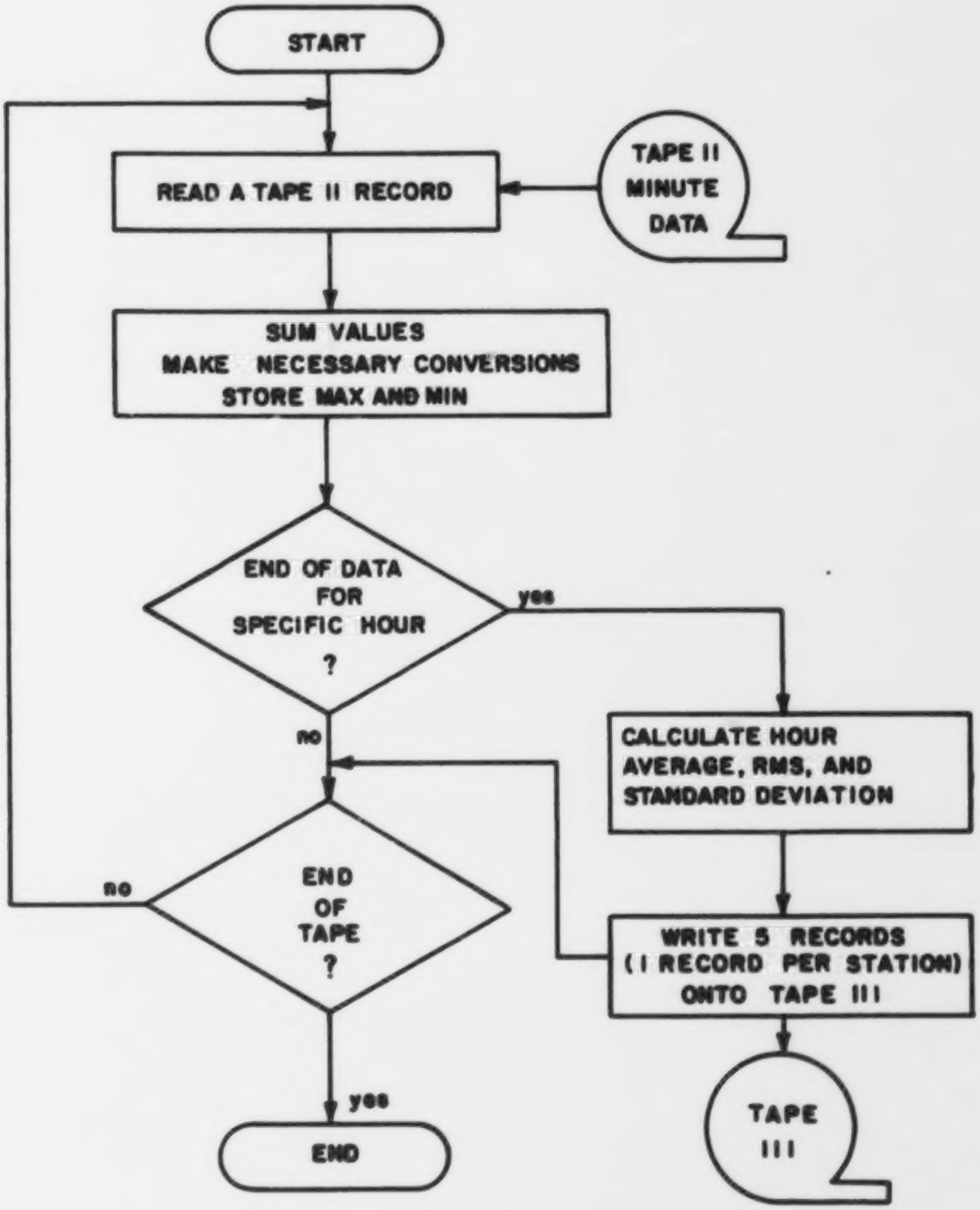

START
READ A TAPE II RECORD
TAPE II
MINUTE
DATA
SUM VALUES
MAKE NECESSARY CONVERSIONS
STORE MAX AND MIN
END OF DATA
FOR
SPECIFIC HOUR
?
yes
no
CALCULATE HOUR
AVERAGE, RMS, AND
STANDARD DEVIATION
END
OF
TAPE
?
no
WRITE 5 RECORDS
(1 RECORD PER STATION)
ONTO TAPE III
yes
END
TAPE
III

Figure I-2. Flowchart for processing of one-hour average tapes (Tape III).

Average: $\bar{x} = \frac{1}{n} \sum_{i}^{n} x_i$ (Eq. 4)

Root Mean Square: $\bar{x}_{RMS} = \sqrt{\frac{\sum_{i}^{n} x_i^2}{n}}$ (Eq. 5)

Standard deviation: $\sigma_x = \sqrt{\frac{\sum_{i}^{n} (x_i - \bar{x})^2}{n-1}}$ (Eq. 6)

where

x_i = Instantaneous one-minute reading for a component

n = Number of valid data points over the hour

The root mean square average concentration was calculated to provide a measure of the average difference from the mean and to show air quality variability from hour to hour, and standard deviation was derived to give the difference from average value (or total deviation of concentration from average, throughout the hour).

The 9-track Tape III series data were then read through an HP-9825 calculator and data were plotted. This step produced a visual display that indicated unreasonable data in terms of trend, time of data change, abrupt change, etc. Suspect data on the plots were visually edited (deleted) from the Tape III series. A list of edits made through this visual inspection is shown in Figure I-3. The final Tape III series was sent to ANL for AQAM evaluation and was used to generate tabular summaries of hourly data, frequency distributions, and wind roses. Final plots of hourly averages for NO, NO_x, CH_4, THC, NMHC, CO, WS, and WD were made and are shown in Appendix H, Figures H-1 to H-91.

The tape characteristics and format are as follows:

Tape III's

Characteristics:

Reels:	7-in (600 ft)
Tracks:	9
Parity:	Odd
Density:	800 BPI
Record Size:	510 characters
Code:	ASCII
Blocking Factor:	1

INDEX of EDITS to WAFB HOURLY DATA

BEGINNING JULIAN DAY	ENDING JULIAN DAY	BEGINNING HOUR	ENDING HOUR	TRAILER	PARAMETER
346	348	12	12	5	NO
359	361	16	11	5	NO
363	364	19	14	5	NO
359	361	13	10	3	NO
362	363	15	14	2	NO
340		12	23	1	NO
346	347	11	10	1	NO
353	354	14	10	1	NO
347	348	12	13	1	NO
360	361	19	11	5	NOX
363	364	18	09	5	NOX
342		07	14	4	NOX
348	349	16	11	2	NOX
346	349	11	13	1	NOX
342	343	15	09	5	CH4
358		07		6	CH4
359		08		6	CH4
363	364	19	09	5	CH4
364		12	14	5	CH4
366		13	14	5	CH4
339	340	17	10	1	CH4
345		14	16	1	CH4
358		07		6	THC
359		08		6	THC
345		14	16	1	THC
366		16	23	5	THC
345		14	16	1	CO
361	362	16	10	4	CO
346		14	23	2	NEPH
308		21		5	NO
331	332	15	23	5	NO
321	323	17	16	2	NO
320	325	17	15	1	NO

BEGINNING JULIAN DAY	ENDING JULIAN DAY	BEGINNING HOUR	ENDING HOUR	TRAILER	PARAMETER
326	327	16	07	1	NO
312		16	23	4	NOX
311	312	23	13	2	CH4
318		14		2	CH4
323		16		2	CH4
322	324	18	15	1	CH4
318		14		2	THC
323		16		2	THC
322	324	18	15	1	THC
318		14		2	CO
332	333	17	11	5	NEPH
276	279	12	11	5	NO
283	284	13	12	5	NO
284	285	12	12	4	NO
289		08	09	4	NO
283	284	13	12	5	NOX
282		08		4	NOX
281	282	19	14	5	CH4
286	287	15	04	2	CH4
304	305	18	09	1	CO
276	277	15	11	4	THC
282		14		4	THC
283	284	20	13	2	THC
068	069	19	10	5	NOX
064		08		5	CH4
076		14		4	CH4
085		16		4	CH4
061		10		3	CH4
071		08		3	CH4
061		10		3	THC
061		10		1	THC
062		08		4	THC
061		08		5	THC
064		08		5	THC

Figure I-3. List of Tape III edits.

Format:

Each record on the tape is separated by an IRG. Each record contains data for one hour and one trailer. The tapes are unlabeled and contain approximately 3,500 records, varying with the number of days in the month being presented. Data for all parameters, for every hour of every day, are accounted for on the tape. Missing or invalid data are indicated by a value of -999.0000. In the event that an average value was missed because of an insufficient number of values (<30) for one-minute data, the third and fourth digits to the right of the decimal point in the above missing data code indicate the number of valid data points that exist for that hour.

Below is information specifying the values contained within each record of the tape and the location of each value within the record. (All character numbers are inclusive and refer to absolute position within the 510-character record.)

8-Character ID Field	Information	
1-3	Julian day (left-justified)	Format A3
4-5	Hour (0-23)	I2
6-8	Trailer number (001-005)	I3

Six 54-Character Air Quality Data Fields:		
9-62	NO	Format 6F9.4
63-116	NO_x	6F9.4
117-170	CH_4	6F9.4
171-224	THC	6F9.4
225-278	CO	6F9.4
279-333	NEPH	6F9.4

Each of these fields contains the following values for the respective parameters:

First 9 characters	Hour average	F9.4
Second 9 characters	Root mean square	F9.4
Third 9 characters	Standard deviation	F9.4
Fourth 9 characters	Minimum value for hour	F9.4
Fifth 9 characters	Maximum value for hour	F9.4
Last 9 characters	Last value (current hour) minus last value (preceding hour)	F9.4

81-Character Met-Data Field:		
333-341	Vector mean wind direction	F9.4
342-350	Average WD	F9.4

351-359	Standard deviation of direction	F9.4
360-368	Vector mean wind speed	F9.4
369-377	Average WS	F9.4
378-386	Standard deviation of speed	F9.4
387-395	$\overline{u'^2}$	F9.4
396-404	$\overline{v'^2}$	F9.4
405-413	$\overline{u'v'}$	F9.4

18-Character Pyranometer Data Field (trailer 4 only):

414-422	Total for hour	F9.4
423-431	Running sum for day	F9.4

The remainder of the record is blank and filled with -0.0000.

METEOROLOGICAL DATA FROM WABAN SHEETS

In addition to the wind speed and direction data collected by the air monitoring network, meteorology information was transcribed from WABAN reports of weather observations at WAFB. Acoustic sounder data were appended to the WABAN information.

The meteorological data were coded on computer forms and typed on tape cartridges. Both were used in constucting a formatted 9-track tape (Met Tape). The process for creating this tape is described in Figure I-4. Copies of the final Met Tape are in the possession of ANL in Chicago, WAFB in Arizona, and EMSL-LV in Las Vegas. The characteristics and format of the Met Tape are described below:

Met Tape

Characteristics:

Parity: Odd
Density: 800 BPI
Code: ASCII
Record Size: 132 characters
Blocking: 38 records/block
File Structure: Each tape contains one file, terminated by three tape marks (23 octal character). Each record is followed by an IRG (19 mm of blank tape).

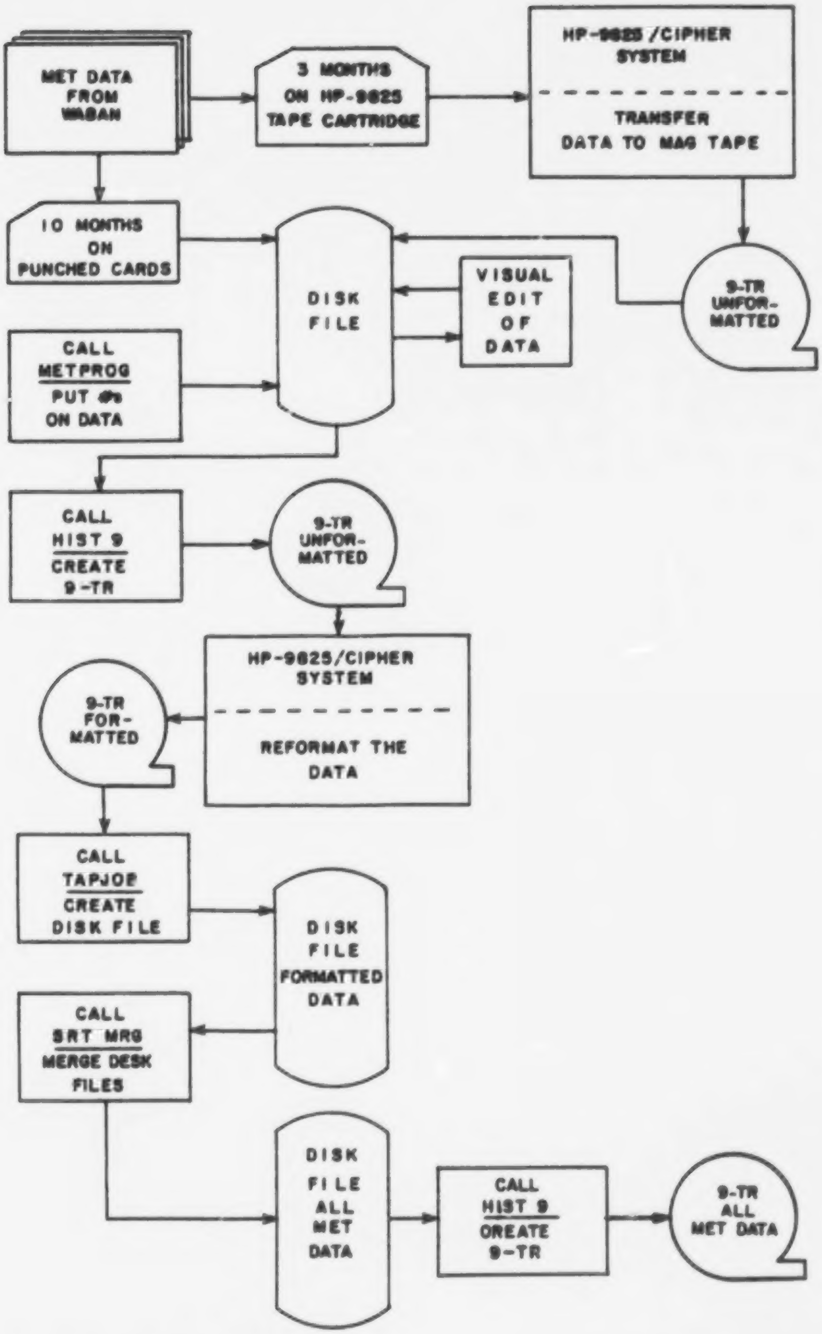

MET DATA FROM WABAN
3 MONTHS ON HP-9825 TAPE CARTRIDGE
HP-9825/CIPHER SYSTEM
TRANSFER DATA TO MAG TAPE
10 MONTHS ON PUNCHED CARDS
DISK FILE
VISUAL EDIT OF DATA
9-TR UNFOR-MATTED
CALL METPROG
PUT #s ON DATA
CALL HIST 9
CREATE 9-TR
9-TR UNFOR-MATTED
HP-9825/CIPHER SYSTEM
REFORMAT THE DATA
9-TR FOR-MATTED
CALL TAPJOE
CREATE DISK FILE
DISK FILE FORMATTED DATA
CALL SRT MRG
MERGE DESK FILES
DISK FILE ALL MET DATA
CALL HIST 9
CREATE 9-TR
9-TR ALL MET DATA

Figure I-4. The process for creating the Met Tape.

Below is information specifying the values contained within each record of the tape and the location of each value within the record. (Also included is a U.S. Department of Commerce NOAA "Key to Aviation Weather Reports" for information.)

8-Character ID Field	Information	
1-3	Julian day (left-justified)	Format A3
4-7	Hour	I4
8	"0" (blank)	I1

Five 8-Character Cloud-Cover Fields

Each field corresponds to one cloud layer. If layer is not present, blanks were reported as:

1	Blank or "E" estimated height "M" measured "W" indefinite "V" variable	A1
2-4	Blank or (left-justified) ceiling height in hundreds of feet above station	A3
5	Blank or "-" thin "x" obscuration	A1
6-8	Sky "CLR" (clear) "SCT" (scattered) "BKN" (broken) "OVC" (overcast)	A3

11-Character Visibility and Weather Field:

1-2	Visibility, reported in statute miles	A2
3-11	Weather and observations if any; otherwise blank	A9

3-Character Pressure Field:

	Only reported every 3 hours; otherwise blank. Sea level pressure in millibars, i.e., 132 reported = 1013.2	A3

4-Character Temperature Field:

1	Delimiter "/"	A4
2-4	Degrees F	

3-Character Dewpoint Field:

1	Delimiter "/"	A4
2-3	Degrees F	

8-Character Wind Field:

1	Delimiter "/"	A8
2-3	WD in tens of degrees from true north	
4-5	WS in knots	
6-8	Blank or gusts in knots	

5-Character Altimeter Setting Field:

1	Delimiter "/"	A5
2-4	Altimiter setting (first figure of report missing)	
5	Delimiter "/" or blank	

43-Character Comments Field:

1-43	Free-format comments	A43

7-Character Acoustic Sounder Field:

1-7	Acoustic sounder data (left-justified)	A7

DATA PRESENTATION

The data contained on the Tape II's and Tape III's were further processed for presentation in the following forms:

- Tabular listings of hourly averages along with the minimum, maximum, and averages for daily and hourly time periods
- Frequency and cumulative frequency data for NO_x, CO, NMHC, and nephelometer
- Log-probability plots of the cumulative frequencies in item 2

- Parameter-versus-time plots of minute data for each trailer for Julian days 027, 131, 272, and 364

- Parameter-versus-time plots of hourly data for each month and trailer for the entire project

- Data completeness summary

- Microfiche of the tabular listings

- Tabular listing of the meteorological data

- A yearly wind rose for each of the five trailers

Tabular Listings

An example of the tabular listings is shown in Figure I-5. The tabular listings were produced on the DOE CDC-6400 computer using a program called Tabular Summaries Software. Standard processing procedure was to create a disk file from a Level III tape and then read the file for processing. A copy of the program is available on request.

Frequencies and Cumulative Frequencies

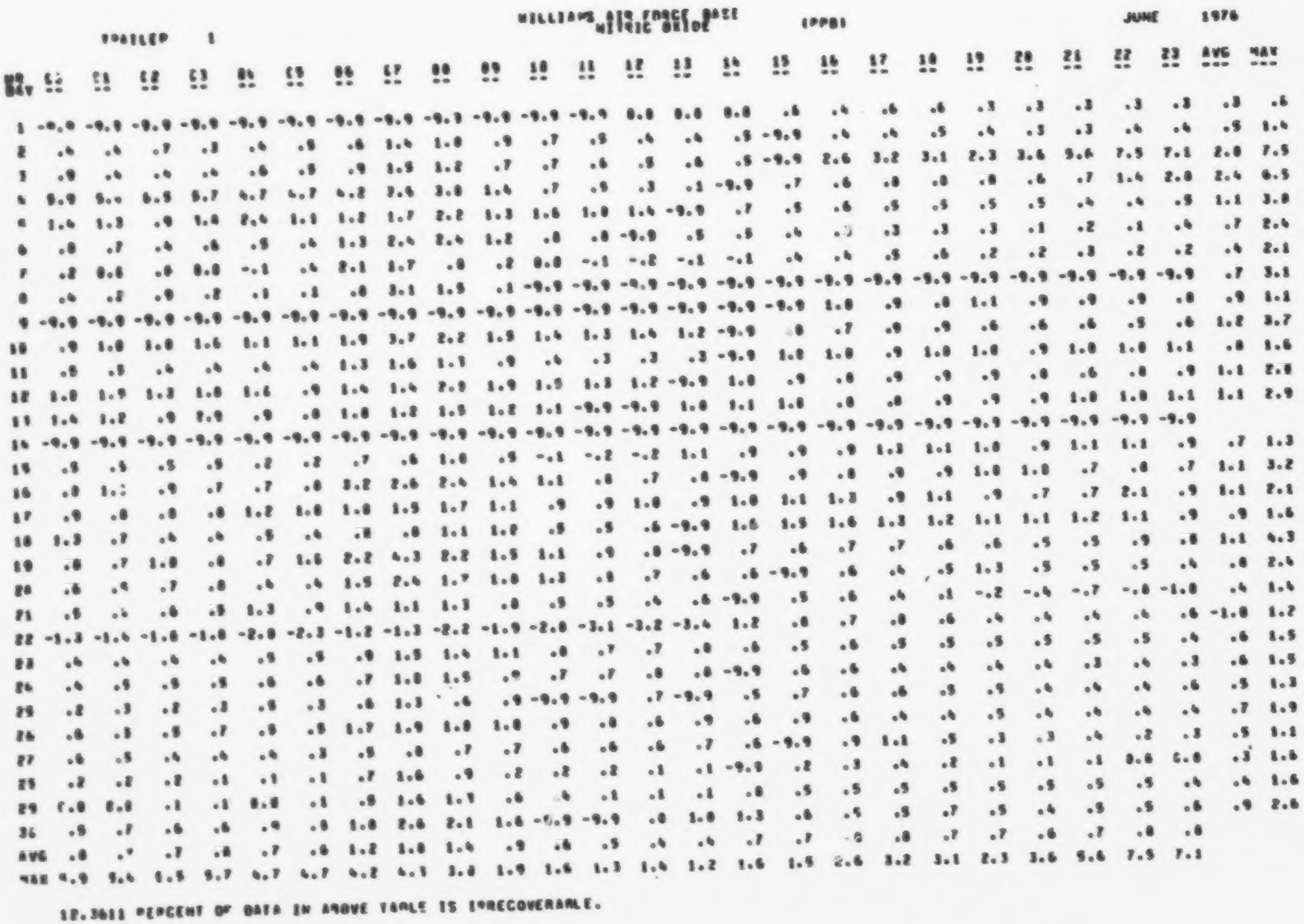
Frequency data were calculated for one year extending from July 1976 through June 1977 for NO_x, CO, NMHC, and b_{scat}. The data for these parameters were accumulated into a yearly file, and the frequency distribution was calculated for the whole year. Computation was done on the DOE CDC-6400. An example of the frequency data is shown in Figure I-6.

Log-Probability Plots

The cumulative frequency data calculated for the yearly period of July 1976 through June 1977 were plotted on log-probability paper. The probability scale on the x-axis is based on the normal law of error. Percent cumulative frequency was plotted on the probability scale and concentration was plotted on the logarithmic axis. An example of the log-probability plots is shown in Figure I-7.

Parameter-versus-Time Plots

Parameter versus time was plotted for both minute data and hourly data. In the case of minute data, the x-axis spanned 24 hours of time and the y-axis gave the concentration of a particular parameter for a particular trailer. For hourly data, the x-axis spanned a month of time and the y-axis showed the parameter concentrations for five trailers. Axes in all cases were linear. The time plots were produced on an HP-9825 system using a 9-track Cipher tape drive and an HP-9862 plotter. The parameters plotted were CO, NO_2, NO, NMHC, b_{scat}, WS, and WD.

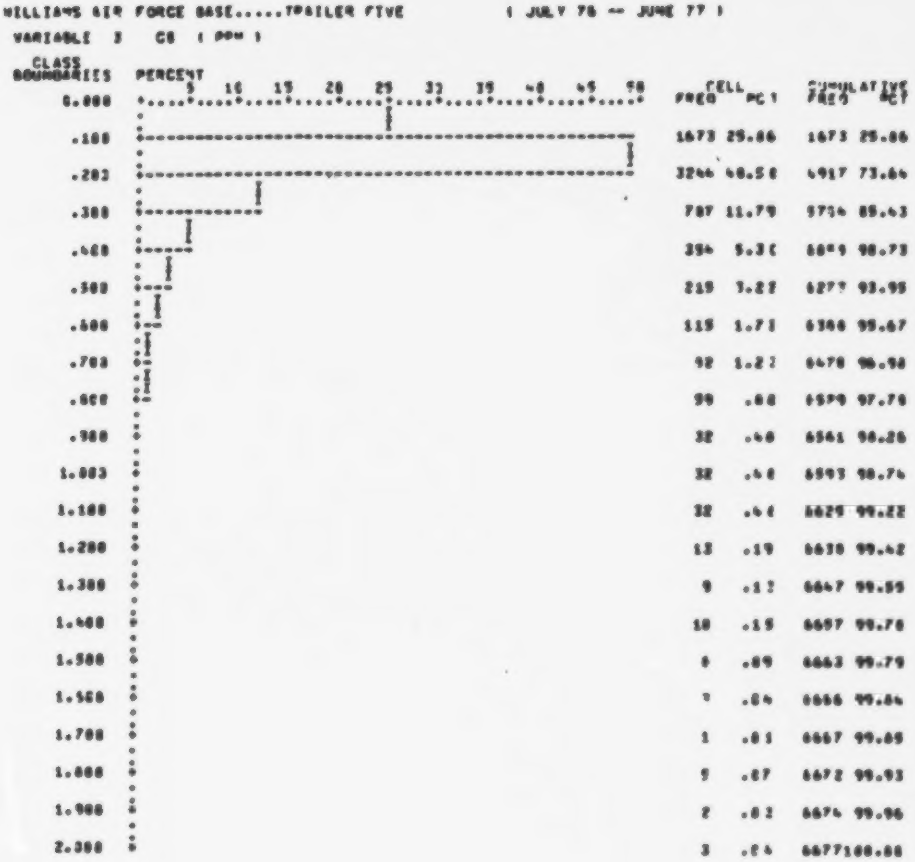


TRAILER 1

WILLIAMS AIR FORCE BASE
NITRIC OXIDE (PPB) JUNE 1976

12.3611 PERCENT OF DATA IN ABOVE TABLE IS IRRECOVERABLE.

Figure I-5. An example of tabular listings for WAFB.



```
WILLIAMS AIR FORCE BASE.....TRAILER FIVE         ( JULY 76 -- JUNE 77 )
 VARIABLE  3   CO  ( PPM )
   CLASS
 BOUNDARIES  PERCENT
                  5    10   15   20   25   30   35   40   45   50        CELL         CUMULATIVE
      0.000                                                           FREQ   PCT     FREQ   PCT
       .100                                                           1673 25.06     1673 25.06
       .200                                                           3244 48.58     4917 73.64
       .300                                                            787 11.79     5704 85.43
       .400                                                            354  5.30     6058 90.73
       .500                                                            215  3.22     6273 93.95
       .600                                                            115  1.72     6388 95.67
       .700                                                             82  1.23     6470 96.90
       .800                                                             59   .88     6529 97.78
       .900                                                             32   .48     6561 98.26
      1.000                                                             32   .48     6593 98.74
      1.100                                                             32   .48     6625 99.22
      1.200                                                             13   .19     6638 99.42
      1.300                                                              9   .13     6647 99.55
      1.400                                                             10   .15     6657 99.70
      1.500                                                              6   .09     6663 99.79
      1.600                                                              3   .04     6666 99.84
      1.700                                                              1   .01     6667 99.85
      1.800                                                              5   .07     6672 99.93
      1.900                                                              2   .03     6674 99.96
      2.000                                                              3   .04     6677100.00
```

Figure I-6. An example of frequency distribution for one year at WAFB.

Data Completeness Summary

A summary of recoverable data was computed for June 1976 through June 1977 showing the percent of recoverable data for all parameters collected by the air monitoring network (Figure I-8).

Microfiche

A print tape of the tabular listings was produced, and this was used to generate a microfiche of the tabular listings. Four microfiche sheets (42x reduction) contain the 520 pages of tabular listings. The microfiche and print tape are available through the EMSL-LV.

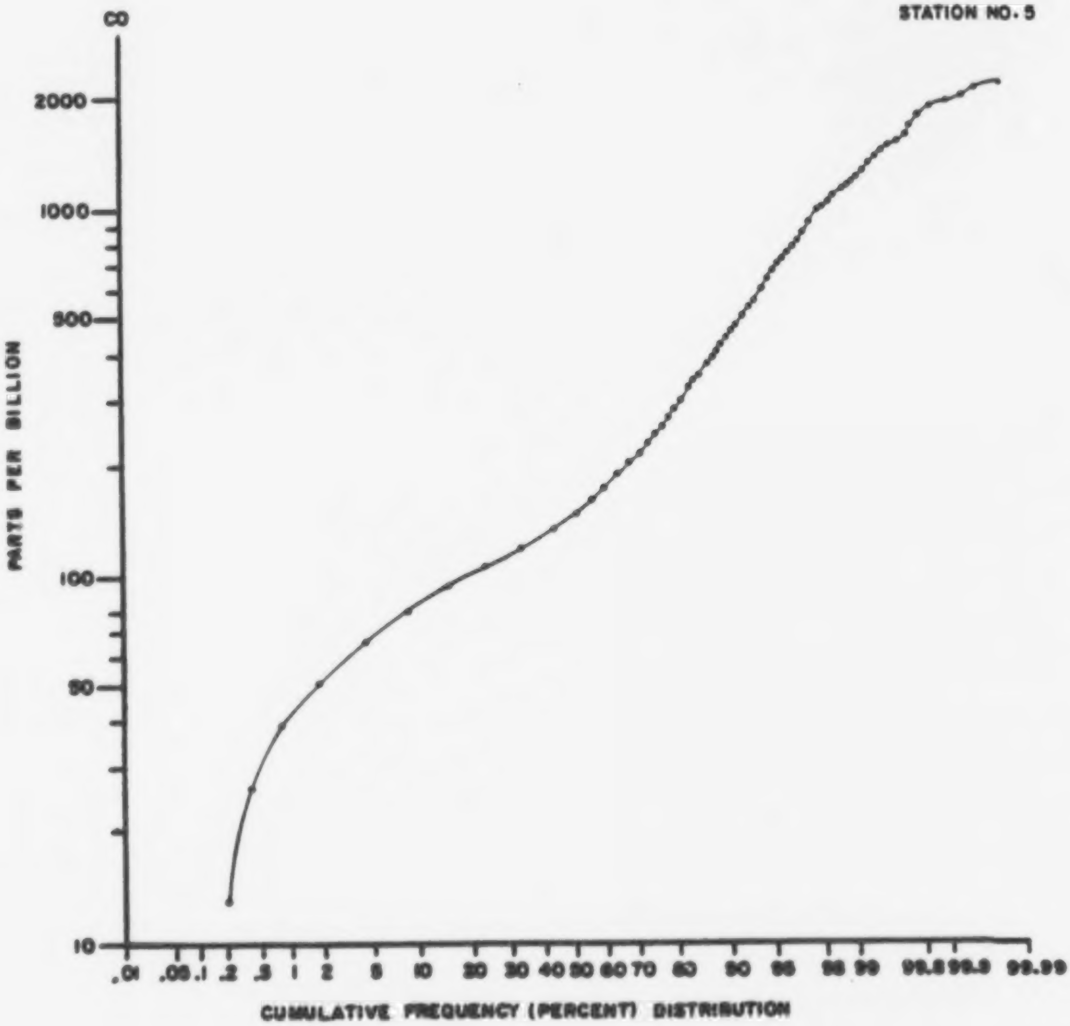


Figure I-7. Example of yearly cumulative frequency distribution of CO.

TRAILER 8 WILLIAMS AIR FORCE BASE PERCENT RECOVERABLE DATA 78/05/09 12.45.26. PAGE 2

		NITRIC OXIDE	OXIDES OF NITROGEN	METHANE	TOTAL HYDROCARBONS	CARBON MONOXIDE	NEPHELOMETER	VECTOR MEAN WIND DIRECTION	VECTOR MEAN WIND SPEED	TOTAL HYDROCARBON -METHANE-
JUNE	76	95.3	95.1	95.3	3.2	95.9	94.3	95.7	95.7	3.2
JULY	76	93.8	93.8	91.8	88.8	90.8	91.8	93.2	93.2	88.8
AUGUST	76	88.7	82.9	85.4	69.4	85.6	88.8	89.7	89.7	69.2
SEPTEMBER	76	59.8	59.5	67.6	67.6	65.8	72.1	74.2	74.2	67.6
OCTOBER	76	92.9	92.9	66.1	61.2	63.3	91.3	93.6	93.6	57.5
NOVEMBER	76	82.4	88.1	57.4	59.3	59.6	87.8	59.7	59.7	57.4
DECEMBER	76	89.3	83.1	83.2	83.7	84.8	86.7	85.9	85.9	83.2
JANUARY	77	61.1	61.3	56.6	61.8	61.8	64.6	62.5	62.5	56.6
FEBRUARY	77	66.7	65.7	61.5	66.4	66.4	66.7	53.6	53.6	61.5
MARCH	77	56.7	56.7	49.2	55.7	54.6	53.5	57.8	57.8	49.2
APRIL	77	89.2	89.2	89.8	89.8	89.8	86.4	89.3	89.3	89.8
MAY	77	88.4	83.4	98.1	88.1	86.1	79.8	90.2	86.1	90.1
JUNE	77	87.9	87.9	85.6	88.5	88.5	88.1	88.6	88.6	85.8

Figure I-8. Summary of recoverable data at WAFB for June 1976 through June 1977.

Meteorological Data

A tabular listing of the Met Tape was produced on the DOE CDC-6400. A sample of the listing is shown in Figure I-9.

Wind Roses

A yearly wind rose for each trailer at WAFB was plotted. The wind roses show the percent occurrence of a particular WD and the WS in each direction (see Section 4 for examples).

CONCATENATION (PACKING) OF LEVEL II TAPES

Level II tapes (395 reels) containing all the aeromatic minute data were concatenated on 20 731-m magnetic tape reels at 1600 BPI. Each concatenated tape contains approximately 20 files of minute data in engineering units. Each file contains a day of data. One set of concatenated Level II tapes has been transmitted to EMSL-LV and an ATLAS library tape copy has been kept on the DOE CDC-6400 computer. No other copies of this data have been made. Copies may be obtained by request to the EPA.

COMPUTER PROGRAMS OF DATA PROCESSING

The following computer programs are presented:

- Correction Program (HP-9825)
- Thumbwheel and Calibration Program (HP-9825)
- Engineering Units Program (HP-9)
- Hourly Averages Program
- Tabular Summaries Software

Following each program is a description of the steps in the program. Additional software is available on request.

Description of the Correction Program

L. 0	Comments
L. 1	Dimension statements
L. 2	Manual entry of last file constructed, which will be modified to construct next file
L. 3	Automatically loads above file into calculator from cassette tape

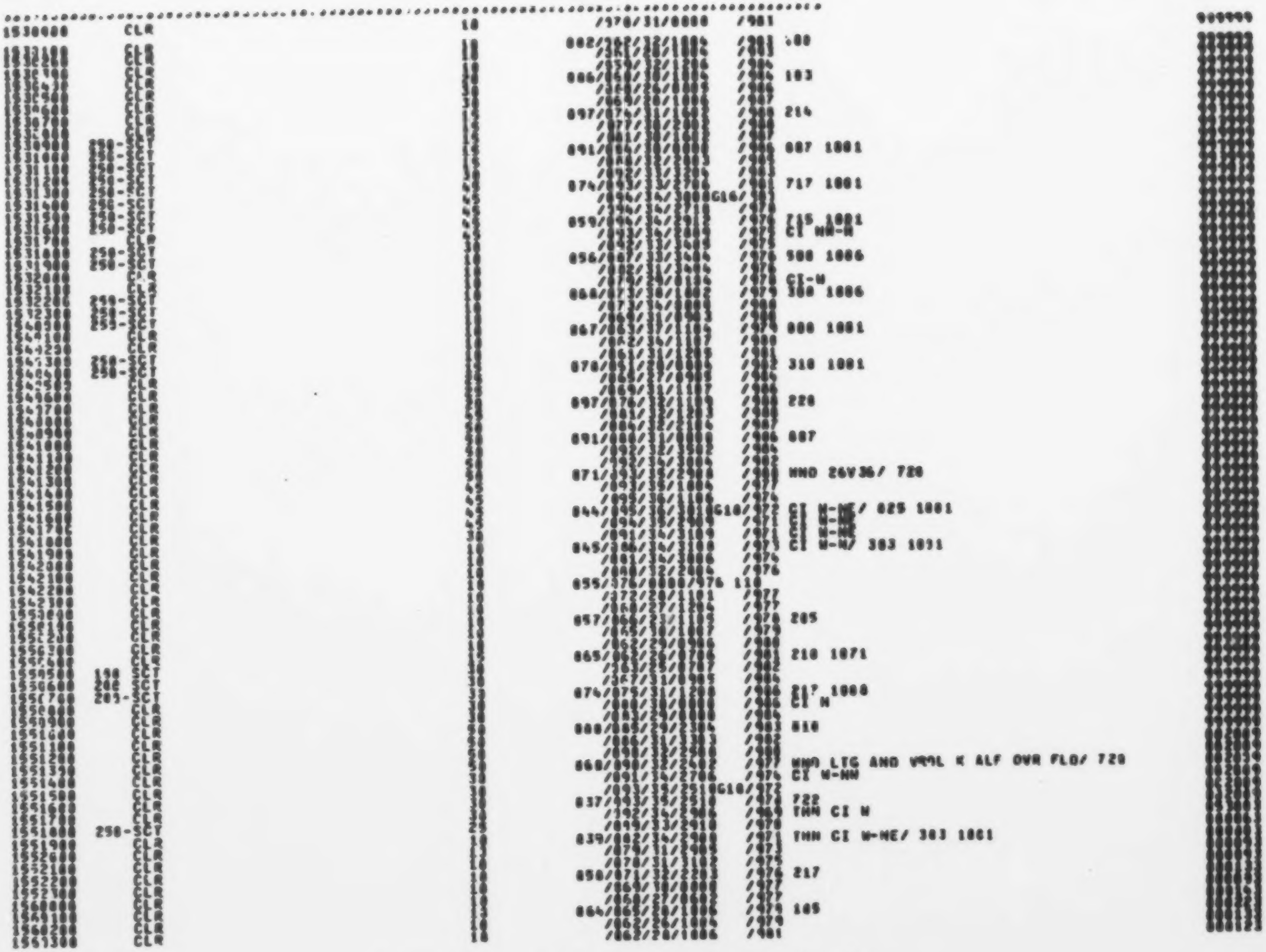


Figure I-9. Sample listing of the Met Tape.

Correction Program

```
0: "WILLIAMS AIR FORCE BASE PROGRAM FOR CALCULATING CORRECTION ARRAYS":
1: dim B[5,6],C[5,6],D[5,6],E[5,6],F[5,6],F$[4],G$[4],T$[4],U$[4]
2: "rst":ent "FILE TO LOAD ?",Z
3: trk 0;ldf Z,B[*],C[*],D[*],E[*],F[*]
4: ent "TRAILER NUMBER ?",B
5: ent "first day ?",V
6: ent "second day ?",W
7: ent "time T1 ?",T$
8: ent "time T2 ?",U$
9: for I=1 to 6
10: V→r1;W→r2;T$[1,4]→F$[1,4];U$[1,4]→G$[1,4]
11: if I=1;gto 17
12: if I=2;gto 18
13: if I=3;gto 19
14: if I=4;gto 20
15: if I=5;gto 21
16: if I=6;gto 22
17: dsp "JULIAN DAY FOR T1,NO",r1;gto 29
18: dsp "JULIAN DAY FOR T1,NOX",r1;gto 30
19: dsp "JULIAN DAY FOR T1,CH4",r1;gto 31
20: dsp "JULIAN DAY FOR T1,THC",r1;gto 32
21: dsp "JULIAN DAY FOR T1,CO",r1;gto 33
22: dsp "JULIAN DAY FOR T1,NEPH",r1;gto 34
23: dsp "JULIAN DAY FOR T2,NO",r2;gto 35
24: dsp "JULIAN DAY FOR T2,NOX",r2;gto 36
25: dsp "JULIAN DAY FOR T2,CH4",r2;gto 37
26: dsp "JULIAN DAY FOR T2,THC",r2;gto 38
27: dsp "JULIAN DAY FOR T2,CO",r2;gto 39
28: dsp "JULIAN DAY FOR T2,NEPH",r2;gto 40
29: dsp "TIME T1 FOR NO",F$;gto 41
30: dsp "TIME T1 FOR NOX",F$;gto 42
31: dsp "TIME T1 FOR CH4",F$;gto 50
32: dsp "TIME T1 FOR THC",F$;gto 43
33: dsp "TIME T1 FOR CO",F$;gto 52
34: dsp "TIME T1 FOR NEPH",F$;gto 44
35: dsp "TIME T2 FOR NO",G$;gto 45
36: dsp "TIME T2 FOR NOX",G$;gto 46
37: dsp "TIME T2 FOR CH4",G$;gto 56
38: dsp "TIME T2 FOR THC",G$;gto 57
39: dsp "TIME T2 FOR CO",G$;gto 58
40: dsp "TIME T2 FOR NEPH",G$;gto 47
41: ent "INITIAL ZERO FOR NO",B[B,I];gto 48
42: ent "INITIAL ZERO FOR NOX",B[B,I];gto 49
43: ent "INITIAL ZERO FOR THC",B[B,I];gto 51
44: ent "INITIAL ZERO FOR NEPH",B[B,I];gto 53
45: ent "FINAL ZERO FOR NO",r4;gto 54
46: ent "FINAL ZERO FOR NOX",r4;gto 55
47: ent "FINAL ZERO FOR NEPH",r4;gto 59
48: ent "INITIAL SPAN FOR NO",r5;gto 60
49: ent "INITIAL SPAN FOR NOX",r5;gto 61
50: ent "INITIAL SPAN FOR CH4",r5;gto 62
51: ent "INITIAL SPAN FOR THC",r5;gto 63
52: ent "INITIAL SPAN FOR CO",r5;gto 64
53: ent "INITIAL SPAN FOR NEPH",r5;gto 65
54: ent "FINAL SPAN FOR NO",r6;gto 66
55: ent "FINAL SPAN FOR NOX",r6;gto 66
56: ent "FINAL SPAN FOR CH4",r6;gto 66
57: ent "FINAL SPAN FOR THC",r6;gto 66
58: ent "FINAL SPAN FOR CO",r6;gto 66
59: ent "FINAL SPAN FOR NEPH",r6;gto 66
```

```
60: ent "CONCENTRATION FOR NO",r7;gto 23
61: ent "CONCENTRATION FOR NOX",r7;gto 24
62: ent "CONCENTRATION FOR CH4",r7;gto 25
63: ent "CONCENTRATION FOR THC",r7;gto 26
64: ent "CONCENTRATION FOR CO",r7;gto 27
65: ent "FREON CAL VOLTAGE FOR NEPH",r7;gto 28
66: r1*1440→r1;r2*1440→r2;val(F$[1,2])*60→A;val(F$[3,4])→S;val(G$[1,2])*60→C
67: val(G$[3,4])→D;r1+A+S→F[B,I];r2+C+D→r2
68: if I=1;gto 74
69: if I=2;gto 74
70: if I=3;gto 76
71: if I=4;gto 76
72: if I=5;gto 76
73: if I=6;gto 77
74: r2-F[B,I]→r8;B[B,I]-r4→r9;r9/r8→C[B,I];r5-B[B,I]→r5;r7/r5→D[B,I]
75: r8*r5→r8;r6-r4→r6;r5-r6→r6;r6/r8→E[B,I];gto 80
76: r7/r5→D[B,I];r5-r6→r6;r2-F[B,I]→r2;r2*r5→r2;r6/r2→E[B,I];gto 80
77: B[B,I]-r4→r8;r2-F[B,I]→r2;r8/r2→C[B,I];3.6/r7→r7;r5-B[B,I]+.09→r9
78: r6-r4+.09→r10;r9/r10→r10;r10*r7→D[B,I];r5-B[B,I]-r6+r4→r10;r2*r9→r9
79: r10/r9→E[B,I];B[B,I]-.09→B[B,I]
80: next I
81: spc 2;fxd 0;prt "TRAILER",B
82: 5→B;fxd 0;prt "TAPE",B
83: 0→B;fxd 0;prt "TRACK",B
84: ent "file to record?",Z
85: fxd 0;prt "FILE",Z;spc 4
86: trk 0;rcf Z,B[*],C[*],D[*],E[*],F[*]
87: for B=1 to 5
88: for I=1 to 6
89: fxd 9;prt B[B,I]
90: next I
91: spc 1
92: next B
93: spc 2
94: for B=1 to 5
95: for I=1 to 6
96: prt C[B,I]
97: next I
98: spc 1
99: next B
100: spc 2
101: for B=1 to 5
102: for I=1 to 6
103: prt D[B,I]
104: next I
105: spc 1
106: next B
107: spc 2
108: for B=1 to 5
109: for I=1 to 6
110: prt E[B,I]
111: next I
112: spc 1
113: next B
114: spc 2
115: for B=1 to 5
116: for I=1 to 6
117: prt F[B,I]
118: next I
119: spc 1
120: next B
121: spc 6
122: csv;0→r0→r1→r2→r3→r4→r5→r6→r7→r8→r9
123: " "→G$[1,4]→T$[1,4]→U$[1,4]→F$[1,4]
124: stp
```

L. 4	Manual entry of trailer number for which calibration or calibration check data is to be entered
L. 5-65	These routines allow manual entry of the values corresponding to the question in the display. These are stored until they are ready to be used in the construction of a correction array.
L. 66-67	Calculates the initial and final times in minutes from the beginning of the year
L. 68-73	Selects the various components and sends the program to the appropriate place to calculate the correction arrays 1 → NO 2 → NO_x 3 → CH_4 4 → THC 5 → CO 6 → Neph
L. 74-75	NO, NO_x: $T_2 - T_1 = r_8$; $V_{01} - V_{02} = r_9$; r_9/r_8 = minute ΔV_0 $V_1 - V_{01} = r_5$ $\frac{C}{r_5}$ = conversion volts to ppm $r_8 \times r_5 \rightarrow r_8$; $V_2 \rightarrow r_6$; $r_5 - r_6 \rightarrow r_6$ r_6/r_8 = minute $\Delta V/V_i - V_{01}$

NOTE:
Array descriptions:

NO, NO_x:	CH_4, THC, CO:	Neph:
$B[B,I] = V_{01}$	$B[B,I] = V_{01} = 0.0$	$B[B,I] - V_{PA1} - .09$
$C[B,I] = \frac{V_{01}-V_{02}}{T_2-T_1}$	$C[B,I] = 0.0$	$C[B,I] = \frac{V_{PA1}-V_{PA2}}{T_2-T_1}$
$D[B,I] = \frac{C}{V_1-V_{01}}$	$D[B,I] = \frac{G}{V_1}$	$D[B,I] = (\frac{\text{Freon } \beta}{V_{FR}})(\frac{V_1-V_{PA1}+.09}{V_2-V_{PA2}+.09})$
$E[B,I] = \frac{(V_1-V_{01})-(V_2-V_{02})}{(T_2-T_1)(V_1-V_{01})}$	$E[B,I] = \frac{V_1-V_2}{(T_2-T_1)(V_1)}$	$E[B,I] = \frac{(V_1-V_{PA1})-(V_2-V_{PA2})}{(T_2-T_1)(V_1-V_{PA1}+.09)}$
$F[B,I] = T_1$	$F[B,I] = T_1$	$F[B,I] = T_1$

L. 76	CH_4, THC, CO: C/V_1=conversion volts to ppm $V_1-V_2=r_6$ $T_2-T_1=r_2=\Delta T$ $\Delta T \times V_1 = r_2$ $\frac{r_6}{r_2} = \frac{V_1-V_2}{(T_2-T_1)V_1}$
L. 77-80	Neph: $V_{PA1}-V_{PA2}\rightarrow r_8;\ T_2-T_1\rightarrow r_2=\Delta T\ \frac{r_8}{r_2}=\frac{V_{PA1}-V_{PA2}}{\Delta T}$ $3.6/V_{FR} = r_7;\ V_1-V_{PA1}+.09;\ V_2-V_{PA1}+.09 \rightarrow I_{10}$ $r_9/r_{10}\rightarrow r_{10};\ r_{10}\times r_7 = \frac{\text{Freon }\beta}{V_{FR}}\left(\frac{V_1-V_{PA1}+.09}{V_2-V_{PA2}+.09}\right)$ $V_1-V_{PA1}-V_2+V_{PA2}=r_{10};\ \Delta T\times r_9\rightarrow r_9;\ r_{10}/r_9=$ $\frac{(V_1-V_{PA1})-(V_2-V_{PA2})}{(T_2-T_1)(V_1-V_{PA1}+.09)}\ V_{PA1}-.09\rightarrow V_{PA1}$
L. 81-85	Outputs comments to printer
L. 86	Records file just created to cassette tape
L. 87-121	Outputs to printer; the file just created
L. 122-123	Zeroes all values for construction of new file

Description of the Thumbwheel and Calibration Program

L. 0	Comments
L. 1-3	Dimension statements
L. 4	Manual entry of tape number
L. 5	Automatic entry of year
L. 6-7	Manual entry of dismount time and clearing of flag 1 for halt at midnight
L. 8-13	Output to printer for identification purposes
L. 14-31	Initialization
L. 32-47	Read routine with check for proper number of characters

Thumbwheel and Calibration Program

```
0: "WILLIAMS AIR FORCE BASE PROGRAM FOR THUMBWEELS AND CAL DATA":
1: dim A$[150],C$[66],B$[50],U[5,3,25],V[5,3,25],W[5,3,25],G[5,3]
2: dim Y[5,7,5],Z[5,7,5],K[5,7],L[5,7],S[5,7,5],T[5,7,5],E[5,7],F[5,7]
3: dim H[5,3],I[5,3]
4: ent "WAFB NUMBER OF TAPE?",r2;r2→O
5: 1976→r3;if r2<153;1977→r3
6: ent "DISMOUNT TIME?",r1;r1→J
7: if r2>88 and r2<153;116→X;1→r4;buf "A",240,4
8: if r2>152 and r2<297;132→X;0→r4;buf "A",270,4
9: if r2<349 and r2>296;90→X;0→r4;buf "A",186,4
10: if r2>351 or r2<89;80→X;1→r4;buf "A",170,64
11: fxd 0;spc 4;prt "DAY",O,"OF",r3
12: fxd 0;spc 2;prt "WAFB NUMBER",O;spc 1;prt "THUMBWHEEL"
13: prt "CHANGES";spc 2
14: " "→A$[1,150]
15: " "→B$[1,50]
16: " "→C$[1,66]
17: "0"→C$[7,7]
18: "1"→C$[2,2]
19: "2"→C$[3,3]
20: "3"→C$[4,4]
21: "4"→C$[9,9]
22: "5"→C$[10,10]
23: "6"→C$[11,11]
24: "7"→C$[12,12]
25: "8"→C$[5,5]
26: "9"→C$[6,6]
27: char(10)→C$[65,65]
28: char(43)→C$[49,49]
29: char(45)→C$[33,33]
30: ctbl C$
31: "str":mdec
32: oni 2,"B"
33: wtc 2,2;tfr 2,"A",X,64
34: rds("A")→A
35: if A=-1;jmp -1
36: gto 31
37: "B":wtc 2,3
38: rds("A")→r1;3→r0;if r1<80;gto "66"
39: if r1=132;fmt z,c132;0→r0
40: if r1=116;fmt z,c116;0→r0
41: if r1=80;fmt z,c80;0→r0
42: if r1=90;fmt z,c90;0→r0
43: conv 64,10
44: if r0=3;dsp " bad data (rec too short)";wait 100;dsp " ";gto "66"
45: red "A",A$
46: if A$[75,75]="+" or A$[75,75]="-";jmp 2
47: gto "66"
48: val(A$[10,10])→B;val(A$[4,5])→r11;val(A$[6,7])→r12;val(A$[8,9])→r13
49: if B#1;jmp 6
50: E+1→E;if E=1;A$[11,20]→B$[1,10];spc 1;gsb "PRT"
51: if A$[11,20]=B$[1,10];jmp 3
52: gsb "PRT"
53: A$[11,20]→B$[1,10]
54: gto "65"
55: if B#2;jmp 6
56: F+1→F;if F=1;A$[11,20]→B$[11,20];spc 1;gsb "PRT"
57: if A$[11,20]=B$[11,20];jmp 3
58: gsb "PRT"
```

```
59: A$[11,20]→B$[11,20]
60: gto "65"
61: if B#3;jmp 6
62: G+1→G;if G=1;A$[11,20]→B$[21,30];spc 1;gsb "PRT"
63: if A$[11,20]=B$[21,30];jmp 3
64: gsb "PRT"
65: A$[11,20]→B$[21,30]
66: gto "65"
67: if B#4;jmp 6
68: H+1→H;if H=1;A$[11,20]→B$[31,40];spc 1;gsb "PRT"
69: if A$[11,20]=B$[31,40];jmp 3
70: gsb "PRT"
71: A$[11,20]→B$[31,40]
72: gto "65"
73: if B#5;jmp 6
74: I+1→I;if I=1;A$[11,20]→B$[41,50];spc 1;gsb "PRT"
75: if A$[11,20]=B$[41,50];jmp 3
76: gsb "PRT"
77: A$[11,20]→B$[41,50]
78: gto "65"
79: "65":if val(A$[4,7])=J;spc 1;gsb "PRT"
80: 37→r5;42→r6;if r4=1;27→r5;32→r6
81: if val(A$[12,12])<2 or val(A$[12,12])>7;jmp 3
82: val(A$[12,12])→D;if E[B,D]>4;jmp 2
83: E[B,D]+1→E[B,D];val(A$[r5,r6])*.0001→S[B,D,E[B,D]]
84: 43→r5;48→r6;if r4=1;33→r5;38→r6
85: if val(A$[13,13])<2 or val(A$[13,13])>7;jmp 3
86: val(A$[13,13])→D;if F[B,D]>4;jmp 2
87: F[B,D]+1→F[B,D];val(A$[33,38])*.0001→T[B,D,F[B,D]]
88: 73→r5;78→r6;if r4=1;63→r5;68→r6
89: if val(A$[18,18])<1 or val(A$[18,18])>6;jmp 3
90: val(A$[18,18])→D;if K[B,D]>4;jmp 2
91: K[B,D]+1→K[B,D];val(A$[r5,r6])*.01→Y[B,D,K[B,D]]
92: 79→r5;84→r6;if r4=1;69→r5;74→r6
93: if val(A$[19,19])<2 or val(A$[19,19])>7;jmp 3
94: val(A$[19,19])→D;if L[B,D]>4;jmp 2
95: L[B,D]+1→L[B,D];val(A$[r5,r6])*.0001→Z[B,D,L[B,D]]
96: 49→r5;54→r6;if r4=1;39→r5;44→r6
97: if val(A$[14,14])<2 or val(A$[14,14])>4;jmp 3
98: val(A$[14,14])→M;M-1→M;if G[B,M]>24;jmp 2
99: G[B,M]+1→G[B,M];val(A$[49,54])*.0001→U[B,M,G[B,M]]
100: 55→r5;60→r6;if r4=1;45→r5;50→r6
101: if val(A$[15,15])<2 or val(A$[15,15])>4;jmp 3
102: val(A$[15,15])→N;N-1→N;if H[B,N]>24;jmp 2
103: H[B,N]+1→H[B,N];val(A$[r5,r6])*.0001→V[B,N,H[B,N]]
104: 61→r5;66→r6;if r4=1;51→r5;56→r6
105: if val(A$[16,16])<2 or val(A$[16,16])>4;jmp 3
106: val(A$[16,16])→R;R-1→R;if I[B,R]>24;jmp 2
107: I[B,R]+1→I[B,R];val(A$[r5,r6])*.0001→W[B,R,I[B,R]]
108: if B=5 and val(A$[4,7])=J;jmp 3
109: "66":buf "A"
110: iret
111: spc 1;prt "NO-NOX";prt "CALIBRATION DATA";spc 2
112: for B=1 to 5
113: for D=1 to 7
114: if E[B,D]=0;jmp 4
115: fxd 0;prt "TRAILER",B;prt "      NO   ",D;spc 1
116: for E=1 to E[B,D];fxd 4;prt S[B,D,E];S[B,D,E]+S→S;next E
117: spc 1;S/E[B,D]→S;prt S;0→S;spc 2
118: if F[B,D]=0;jmp 4
119: fxd 0;prt "TRAILER",B;prt "      NOX  ",D;spc 1
120: for F=1 to F[B,D];fxd 4;prt T[B,D,F];T[B,D,F]+T→T;next F
121: spc 1;T/F[B,D]→T;prt T;0→T;spc 2
122: next D
123: next B
```

```
124: spc 2;prt "WIND DIRECTION";prt "AND HEPHELOMETER";prt "CALIBRATION DATA"
125: spc 2
126: for B=1 to 5
127: for D=1 to 7
128: if K[B,D]=0;jmp 4
129: fxd 0;prt "TRAILER",B;prt "      WD   ",D;spc 1
130: for K=1 to K[B,D];fxd 4;prt Y[B,D,K];Y[B,D,K]+Y→Y;next K
131: spc 1;Y/K[B,D]→Y;prt Y;0→Y;spc 2
132: if L[B,D]=0;jmp 4
133: fxd 0;prt "TRAILER",B;prt "      NEPH ",D;spc 1
134: for L=1 to L[B,D];fxd 4;prt Z[B,D,L];Z[B,D,L]+Z→Z;next L
135: spc 1;Z/L[B,D]→Z;prt Z;0→Z;spc 2
136: next D
137: next B
138: spc 2;prt "CH4, THC, AND CO";prt "CALIBRATION DATA";spc 2
139: for B=1 to 5
140: for D=1 to 3
141: if G[B,D]=0;jmp 4
142: fxd 0;prt "TRAILER",B;prt "      CH4  ",D+1;spc 1
143: for G=1 to G[B,D];fxd 4;prt U[B,D,G];U[B,D,G]+U→U;next G
144: spc 1;U/G[B,D]→U;prt U;0→U;spc 2
145: if H[B,D]=0;jmp 4
146: fxd 0;prt "TRAILER",B;prt "      THC  ",D+1;spc 1
147: for H=1 to H[B,D];fxd 4;prt V[B,D,H];V[B,D,H]+V→V;next H
148: spc 1;V/H[B,D]→V;prt V;0→V;spc 2
149: if I[B,D]=0;jmp 4
150: fxd 0;prt "TRAILER",B;prt "      CO   ",D+1;spc 1
151: for I=1 to I[B,D];fxd 4;prt W[B,D,I];W[B,D,I]+W→W;next I
152: spc 1;W/I[B,D]→W;prt W;0→W;spc 2
153: next D
154: next B
155: dsp "tape at midnight";beep;beep;stp
156: "PRT":
157: fxd 0;prt "TRAILER",B;prt A$[4,9];prt A$[11,20];spc 1
158: ret
```

L. 48	Assignment of trailer number to B
L. 49-54	For trailer 1, E is the counter and if equal to 1, then the thumbwheels are stored for comparison and printed out. If E does not equal 1, then current value is compared with stored value. If they are the same, program continues; if not, then the thumbwheel values and time are printed out.
L. 55-60	Same as above for trailer 2 except F is the counter
L. 61-66	Same as above for trailer 3 except G is the counter
L. 67-72	Same as above for trailer 4, except H is the counter
L. 73-78	Same as above for trailer 5, except I is the counter
L. 79-80	Check to see if tape has passed midnight and is at the end; if so, thumbwheels are printed out.
L. 81-107	The following routines check each thumbwheel individually for a calibration or calibration check value. If the thumbwheel is not one of these values, the program continues. If it is a calibration value, then the value is stored in an array made up of the trailer number and thumbwheel value. Each has a counter so that only the proper number of values is stored.
L. 108	Check to see if tape is at midnight. If so, flag 1 is set and calibration values are output.
L. 111-117	The following routines output the calibration or calibration check data to the printer under the appropriate heading. First the counters are checked and, if zero, no output occurs. If other than zero, the trailer number and appropriate component and thumbwheel value are output. These are followed by the individual calibration and calibration check values. These are averaged and the average is output. As an example, NO_x will be used.
L. 118	Counter check
L. 119	Output trailer number and component, and skip a space.
L. 120	Print out and add up the individual values.
L. 121-123	Skip a space, calculate the average. Output the average, skip two spaces, and go on to the next trailer.
L. 155	Alert operator to change tapes.
L. 156-158	End of program

Engineering Units Program

```
0: dim A$[132],C$[66],B$[92],T$[132],B[5,6],C[5,6],D[5,6],E[5,6],F[5,6];30→Z
1: dim J$[3]
2: trk 0;ldf 19,B[*],C[*],D[*],E[*],F[*];wti 0,2
3: buf "A",170,4
4: "str":" "→C$[1,66]
5: "0"→C$[7,7]
6: "1"→C$[2,2]
7: "2"→C$[3,3]
8: "3"→C$[4,4]
9: "4"→C$[9,9]
10: "5"→C$[10,10]
11: "6"→C$[11,11]
12: "7"→C$[12,12]
13: "8"→C$[5,5]
14: "9"→C$[6,6]
15: char(10)→C$[65,65]
16: char(43)→C$[49,49]
17: char(45)→C$[33,33]
18: ctbl C$
19: mdec
20: oni 2,"B"
21: wtc 2,2;tfr 2,"A",Z,64
22: rds("A")→Y
23: if Y=-1;jmp -1
24: gto "str"
25: "B":wtc 2,3
26: conv 64,10
27: rds("A")→W;if W<77;gto "setz"
28: fmt z,c80
29: if W=77;fmt z,c77
30: if W=78;fmt z,c78
31: if W=79;fmt z,c79
32: if W=81;fmt z,c81
33: if W>81;gto "setz"
34: red "A",A$
35: if W=81;""→A$[81,81];gto "rst"
36: if W#80;beep;beep;dsp "CH REC",W;stp
37: "rst":if A$[75,75]="+" or A$[75,75]="-";jmp 2
38: gto "setz"
39: val(H$[10,10])→B;val(A$[4,9])→E;val(A$[1,3])*1440→r3;val(A$[4,5])*60→r4
40: 87→J;"087"→J$[1,3];val(A$[4,5])→r11;val(A$[6,7])→r12;val(A$[8,9])→r13
41: if B=2 and E>135700;"99"→A$[14,14]
42: if B=2 and E>=92400 and E<=112500;gto "setz"
43: if B=9 and E>=130000 and E<=134900;gto "setz"
44: if B=2 and E>=144900 and E<=153700;gto "setz"
45: if B=3 and E>=133206 and E<=142706;gto "setz"
46: if B=4 and E>=133713 and E<=143413;gto "setz"
47: if B=5 and E>=122120 and E<=131520;gto "setz"
48: val(A$[6,7])→r5;r3+r4+r5→X
49: val(A$[1,3])→r15;if r15#J;beep;beep;dsp "CHECK THE DAY";stp
50: val(A$[27,32])*.0001→C;val(A$[12,12])→D;if D=9;-9.9999→C
51: val(A$[33,38])*.0001→F;val(A$[13,13])→G;if G=9;-9.9999→F
52: val(A$[39,44])*.0001→H;val(A$[14,14])→K;if K=9;-9.9999→H
53: val(A$[45,50])*.0001→L;val(A$[15,15])→M;if M=9;-9.9999→L
54: val(A$[51,56])*.0001→N;val(A$[16,16])→O;if O=9;-9.9999→N
55: val(A$[57,62])*.0001→P;val(A$[17,17])→Q;if Q=9;9.9999→P
56: val(A$[63,68])*.0001→R;val(A$[18,18])→S
57: if R<0;0→R
58: if R>3.52;3.52→R
59: if S=9;-9.9999→R
```

```
60: val(A$[69,74])*.0001→T;val(A$[19,19])→U;if U=9;-9.9999→T
61: if B=4;val(A$[75,80])*.0001→V;jmp 2
62: 0→V
63: if D=9;jmp 4
64: if B=3;C-B[B,1]→C
65: X-F[B,1]→r1;r1*C[B,1]→r2;C+r2→C;C*D[B,1]→C;r1*E[B,1]→r2
66: 1+r2→r2;C*r2→C
67: if G=9;jmp 4
68: if B=3;F-B[B,2]→F
69: X-F[B,2]→r1;r1*C[B,2]→r2;F+r2→F;F*D[B,2]→F;r1*E[B,2]→r2
70: 1+r2→r2;F*r2→F
71: if K=9;jmp 2
72: H*D[B,3]→H;X-F[B,3]→r1;r1*E[B,3]→r1;1+r1→r1;H*r1→H
73: if M=9;jmp 2
74: L*D[B,4]→L;X-F[B,4]→r1;r1*E[B,4]→r1;1+r1→r1;L*r1→L;L+B[B,4]→L
75: if O=9;jmp 2
76: N*D[B,5]→N;X-F[B,5]→r1;r1*E[B,5]→r1;1+r1→r1;N*r1→N
77: if U=9;jmp 3
78: T-B[B,6]→T;X-F[B,6]→r1;r1*C[B,6]→r2;T-r2→T;T*D[B,6]→T;r1*E[B,6]→r1
79: 1+r1→r1;T*r1→T
80: A$[1,20]→B$[1,20]
81: fxd 4
82: if C<-9.9999 or C>99.9999;-99.9999→C
83: if F<-9.9999 or F>99.9999;-99.9999→F
84: if H<-9.9999 or H>99.9999;-99.9999→H
85: if L<-9.9999 or L>99.9999;-99.9999→L
86: if N<-9.9999 or N>99.9999;-99.9999→N
87: if P<-9.9999 or P>99.9999;-99.9999→P
88: if R<-9.9999 or R>99.9999;-99.9999→R
89: if T<-9.9999 or T>99.9999;-99.9999→T
90: if V<-9.9999 or V>99.9999;-99.9999→V
91: str(C)→B$[21,28]
92: str(F)→B$[29,36]
93: str(H)→B$[37,44]
94: str(L)→B$[45,52]
95: str(N)→B$[53,60]
96: str(P)→B$[61,68]
97: str(R)→B$[69,76]
98: str(T)→B$[77,84]
99: str(V)→B$[85,92]
100: ctbl
101: "91":moct;fxd 0;0→r10;if iof2=0;1→r10
102: if flg1;dsp "I/O ctrl:",iof2,ios2,rdi 4,rdi 5,W
103: if r10=1;wti 5,47;mdec
104: fmt z,c93;wrt 2,B$
105: I+1→I;wait 10
106: moct;wti 6,160000;wti 6,170000;mdec
107: ctbl C$
108: "setz":80→Z
109: if E=112500;trk 0;ldf 19,B[*],C[*],D[*],E[*],F[*]
110: if E=131520;trk 0;ldf 20,B[*],C[*],D[*],E[*],F[*]
111: if E=142706;trk 0;ldf 21,B[*],C[*],D[*],E[*],F[*]
112: if E=143413;trk 0;ldf 22,B[*],C[*],D[*],E[*],F[*]
113: if E=153700;trk 0;ldf 23,B[*],C[*],D[*],E[*],F[*]
114: if E=999999;trk 1;ldf 109,B[*],C[*],D[*],E[*],F[*]
115: "mid":if B=5 and r11=12 and r12=8;beep;dsp "change 7-track tape";stp
116: if B=5 and E>235900;dsp "tape at midnight";stp
117: "cla":buf "A"
118: iret
119: "day":J$[1,3]→A$[1,3];gto "rst"
120: "tstr":A$[1,79]→T$[1,79];" "→A$[1,80];T$[1,79]→A$[2,80];gto "day"
121: "tstr2":A$[1,78]→T$[1,78];" "→A$[1,80];T$[2,78]→A$[4,80];gto "day"
122: "tstr3":A$[1,77]→T$[1,77];" "→A$[1,80];T$[1,77]→A$[4,80];gto "day"
123: "rec":fxd 0;spc 4;prt I;prt "RECORDS WRITTEN TO WAFB TAPE #",J;spc 10
124: stp
```

Description of the Engineering Units Program

L. 0	Dimension statements and assignment of record length
L. 1-2	Manual loading of correction file
L. 3	Buffer size and type
L. 4-17	Initialization and setting up of table
L. 18-38	Tape read with check for record size and proper characters
L. 39	Value assignments: B = Trailer number E = Time in hours, minutes, seconds r_3 = Day in minutes r_4 = Hour in minutes
L. 40	Value assignments: 73 = J = day 073 → J$[1,3] r_{11} = Hour r_{12} = Minutes r_{13} = Seconds
L. 41	Statement to allow for thumbwheel changes in a given trailer
L 42-47	Statements to allow the skipping of a trailer for calibration, calibration check, or any other reason desired
L. 48	x = Time in minutes
L. 49	Check to make sure the day is correct.
L. 50	C = NO voltage value; if thumbwheel = 9, then c is set equal to -9.9999. D is thumbwheel number.
L. 51	NO_x voltage value; if thumbwheel = 9, then F is set equal to -9.9999. G is thumbwheel number.
L. 52	Same as above except for CH_4
L. 53	Same as above except for THC
L. 54	Same as above except for CO
L. 55	Same as above except for wind speed
L. 56-58	Same as above except for wind direction. A test is made to correct for an overshoot when direction passes the 8° null band.
L. 60	Same as above except for nephelometer

L. 61-62	If the trailer number is 4, then a value (pyranometer) is given to V; otherwise it is zero.
L. 63-66	For NO, thumbwheel is checked for proper value. If OK, then, at this point, changes may be made to the data. In this case, NO value for trailer 3 was changed to correct for a problem, then the following calculation was made for all trailers: $\text{ppm} = [V_1 - V_{01} + T_i \frac{V_{01} - V_{02}}{T_2 - T_1}] (\frac{C}{V_1 - V_{01}}) [1 + T_i] \frac{(V_1 - V_{01}) - (V_2 - V_{02})}{(T_2 - T_1)(V_1 - V_{01})}$
L. 67-70	Same as above except for NO_x. NOTE: Refer also to Correction Array Program for explanation of variables.
L. 71-72	Same as above except for CH_4 and equation: $\text{ppm} = (\frac{C}{V_1}) (1 + T_i \frac{V_1 - V_2}{(T_2 - T_1)(V_1)})$
L. 73-74	Same as above except for THC
L. 75-76	Same as above except for CO
L. 77-79	For nephelometer and calculate following: $\beta = [V_1 - (V_{PA1} - .09) - T_i \frac{V_{PA1} - V_{PA2}}{T_2 - T_1}] [(\frac{\text{Freon}}{V_{FR}}) (\frac{V_1 - V_{PA1} + .09}{V_2 - V_{PA2} + .09})]$ $(1 + T_i \frac{(V_1 - V_{PA1} + .09) - (V_2 - V_{PA2} + .09)}{(T_2 - T_1)(V_1 - V_{PA1} + .09)})$
L. 80	Assigns first 20 characters on 7-track to first 20 characters on 9-track.
L. 81-90	This checks each component for obviously wrong values.
L. 91-99	Assigns values to array for writing to 9-track
L. 100-107	Writes on 9-track
L. 109-114	These statements read in correction arrays at specified times. Manually input.
L. 115	Indicates tape is at end and must be replaced to continue.

L. 116	Indicates that tape is at midnight
L. 117-118	Sets up buffer and clears interrupt
L. 119-122	Various programs for correcting recurring errors in records and changes from tape to tape
L. 123	Counter for number of records written on 9-track. This is outputted to the printer.

Description of Hourly Averages Program

L. 0-7	Title header and comments
L. 8-9	Dimension statements
L. 11-17	Variable initialization Minimum value array filled with 999
L. 18	Manual entry of Julian day of tape
L. 28-29	Automatic entry of stop and start times
L. 30-31	Start time in hour, minute, second, reduced to hours plus 1/2 hour
L. 32-37	Auto entry of stop and start times
L. 38-39	Buffer size and type Decimal mode
L. 40-42	Interrupt read routine
L. 43	Start tape drive, transfer 93 characters Start of mainline
L. 45	End of interrupt read routine
L. 46-48	Interrupt service routine
L. 49	Read Buffer into a $
L. 50-51	Test string for proper length
L. 55	If improper, increment counter and reject record
L. 56	Extract record time, convert to seconds
L. 57	Station ID number = B
L. 58	Test for valid station ID

Hourly Averages Program

```
0: "WILLIAMS AFB MINUTE TO HOUR AVERAGE DATA REDUCTION PROGRAM":
1: "9 TRACK  ASCII TO 9TRACK ASCII":
2: "BY       NICK REESE    03NOV77":
3: "510 CHARACTER RECORDS":
4: "VERSION 5A  REV 1.9A":
5: "READING OF SHIFTED TAPE II RECORDS":
6: "AUTO LOADING OF START, STOP TIMES":
7: "NO MET READS OR ROUTINES":
8: dim A$[250],D$[10],B$[25],C$[200],Z[50],E$[90],C[230],D[40],E[30],F[30]
9: dim G[300],X[5,3],Y[5,3],H[36]
10: trk 0
11: sfg 14;sfg 4;" "→D$[1,10];" "→E$[1,18];30→R;173400→Z
12: for I=15 to 165 by 30
13: for J=1 to 5
14: 999→C[I+J]
15: next J
16: next I
17: fxd 0;wti 0,2
18: ent "JULIAN DAY OF TAPE",E
19: ent "IF COLD START ENT. 1 OTHERWISE 0",r45
20: 0→r46;if r45=1;1→r46;jmp 2
21: dsp "MAKE SURE TAPE",E-1,"IS MOUNTED";stp
22: ent "READ DATA CART. ?  0=YES 1=NO",r51;if r51;jmp 4
23: dsp "MAKE SURE SCRATCH CART IS LOADED";stp
24: if r45;trk 0;ldf 1,C[*]
25: if r45;for I=1 to 40;30→D[I];next I
26: "first start time":"233010"→D$
27: gto +2
28: ent "START TIME",D$
29: val(D$[1,2])*3600+val(D$[3,4])*60+val(D$[5,6])→r33
30: int(r33/3600)→r6
31: r6*3600+1800→r6
32: "first stop time":"235700"→D$
33: jmp 2
34: ent "LAST RECORD TIME, (more or less) ",D$
35: val(D$[1,2])*3600+val(D$[3,4])*60+val(D$[5,6])→r34
36: "second start and stop time (hours*3600+min*60+seconds) ":
37: 0→r43;84611→r44
38: buf "A",93,4
39: moct
40: oni 2,"B"
41: wti 0,2
42: wti 6,Z;tfr 2,"A",93,0
43: rds("A")→Y
44: if Y=-1;jmp -1
45: gto 40
46: "B":wti 6,177400;wti 0,3
47: if not flg9;on err "ERROR";sfg 9
48: fmt z,c92
49: red "A",A$
50: if r0>1;dsp A$[1,32]
51: if A$[1,1]#" ";A$[1,92]→A$[2,92];" "→A$[1,1]
52: if r0;dsp A$[1,32]
53: if S;gto 396
54: if A$[86,86]=" " or A$[36,86]="-";jmp 2
55: r42+1→r42;gto 78
56: val(A$[5,6])*3600+val(A$[7,8])*60+val(A$[9,10])→W
57: val(A$[11,11])→B
```

```
58: if B<1 or B>5;r42+1→r42;gto 78
59: if val(A$[5,10])>236000;1+r42→r42;gto 80
60: if not r45;if W<r33;cfg 5;gto 78
61: if r45;if W<r43;gto 78
62: if not flg4;r6+3600→r6;sfg 4
63: if r46;if val(A$[7,10])>=3000;sfg 5;cfg 4;0→r46
64: if not r46;if val(A$[7,10])<3000;1→r46
65: if r45;if W>r7;if r7+15>W;jmp 2
66: jmp 2
67: if flg4;if W>=r6;cfg 4;sfg 5
68: W→r7
69: if r45;if W>r44;if not S;1→S;gsb "T"
70: if r45;if W>r44;if not S;gto "END"
71: if not r45;if W>r34;if not S;1→S;gsb "T"
72:
73: if not r45;if W>r34;if not S;wti 6,175400;wti 6,177400;rcf 1,C[*]
74: if not r45;if W>r34;dsp "LOAD TAPE #",E,"    -CONTINUE";1→r45;stp
75: if flg5;if not S;1→S;gsb "T"
76: if flg5;if not S;gsb "WRITE"
77: gsb "C"
78: buf "A"
79: if not flg9;on err "ERROR";sfg 9
80: iret
81: "C":
82: val(A$[2,4])*86400+W→X
83: val(A$[22,28])→C;val(A$[13,13])→D
84: val(A$[30,36])→F;val(A$[14,14])→G
85: val(A$[38,44])→H;val(A$[15,15])→K
86: val(A$[46,52])→L;val(A$[16,16])→M
87: val(A$[54,60])→N;val(A$[17,17])→O
88: val(A$[62,68])→r1;val(A$[18,18])→r2
89: val(A$[70,76])→r3;val(A$[19,19])→r4
90: val(A$[78,84])→T;val(A$[20,20])→U
91: if B=4;val(A$[86,92])→r36;r36/.00676→r36
92: fmt 8,f1.0,1x,f1.0,1x,f1.0,4x,f9.4
93: if P#B;jmp 9
94: if Q=1;wrt .8,B,Q,D,C
95: if Q=2;wrt .8,B,Q,G,F
96: if Q=3;wrt .8,B,Q,K,H
97: if Q=4;wrt .8,B,Q,M,L
98: if Q=5;wrt .8,B,Q,O,N
99: if Q=6;wrt .8,B,Q,U,T
100: if Q=7;wrt .8,B,Q,r2,r1
101: if Q=8;wrt .8,B,Q,r4,r3
102: "NO":
103: "---NO---":
104: if D=0 or D=1;jmp 2
105: gto 114
106: if C<=-.05 or C>.49;H[B]+1→H[B];gto 114
107:
108: D[B]+1→D[B]
109: C+C[B]→C[B]
110: CC+C[5+B]→C[5+B]
111: C→E[B]
112: if C<C[15+B];C→C[15+B]
113: if C>C[20+B];C→C[20+B]
114:
115: "NOX":
116: "---NOX---":
117: if G=0 or G=1;jmp 2
118: gto 127
119: if F<=-.05 or F>.49;H[B+5]+1→H[B+5];gto 127
```

```
120:
121: D[5+B]+1→D[5+B]
122: F+C[30+B]→C[30+B]
123: FF+C[35+B]→C[35+B]
124: F→E[5+B]
125: if F<C[45+B];F→C[45+B]
126: if F>C[50+B];F→C[50+B]
127:
128: "CH4":
129: "---CH4---":
130: if K=0 or K=1;jmp 2
131: gto 142
132: if H<=1.3 or H>7.9;H[B+10]+1→H[B+10];gto 142
133:
134: D[10+B]+1→D[10+B]
135: H+C[60+B]→C[60+B]
136: HH+C[65+B]→C[65+B]
137: H→E[10+B]
138: if H<C[75+B];H→C[75+B]
139: if H>C[80+B];H→C[80+B]
140:
141: "THC":
142: "---THC---":
143: if M=0 or M=1;jmp 2
144: gto 155
145: if L<=1.3 or L>7.9;H[B+15]+1→H[B+15];gto 155
146:
147: D[15+B]+1→D[15+B]
148: L+C[90+B]→C[90+B]
149: LL+C[95+B]→C[95+B]
150: L→E[15+B]
151: if L<C[105+B];L→C[105+B]
152: if L>C[110+B];L→C[110+B]
153:
154: "CO":
155: "---CO---":
156: if O=0 or O=1;jmp 2
157: gto 168
158: if N<=0 or N>7.9;H[B+20]+1→H[B+20];gto 168
159:
160: D[20+B]+1→D[20+B]
161: N+C[120+B]→C[120+B]
162: NN+C[125+B]→C[125+B]
163: N→E[20+B]
164: if N<C[135+B];N→C[135+B]
165: if N>C[140+B];N→C[140+B]
166:
167: "NEPH":
168: "---NEPH---":
169: if U=0 or U=1;jmp 2
170: gto 179
171: if T<=0 or T>9.9;H[B+25]+1→H[B+25];gto 179
172:
173: D[25+B]+1→D[25+B]
174: T+C[150+B]→C[150+B]
175: TT+C[155+B]→C[155+B]
176: T→E[25+B]
177: if T<C[165+B];T→C[165+B]
178: if T>C[170+B];T→C[170+B]
```

```
179:
180: "WS, WA":
181: if r2=0 or r2=1;jmp 2
182: gto 208
183: if r4=0;jmp 2
184: gto 208
185: if r3<0 or r1>3.5;H[30+B]+1→H[30+B];gto 208
186: if r3>3.52;H[30+B]+1→H[30+B];gto 208
187: r3*100→r3;r1*10→r1
188: 1+D[30+B]→D[30+B]
189: B+290→r20
190: for I=r20 to B by -5
191: G[I]→G[I+5];if I=B;r3→G[B]
192: next I
193: sin(r3)→r10;cos(r3)→r11
194: r1*r10+C[195+B]→C[195+B]
195: r1*r11+C[180+B]→C[180+B]
196: r10+C[185+B]→C[185+B];r11+C[190+B]→C[190+B]
197: (X[B,1]*2-X[B,2])*.85+.15*r1*r10→r13
198: X[B,2]→X[B,3];X[B,1]→X[B,2];r13→X[B,1]
199: (Y[B,1]*2-Y[B,2])*.85+.15*r1*r11→r14
200: Y[B,2]→Y[B,3];Y[B,1]→Y[B,2];r14→Y[B,1]
201: r13*r13+r14*r14→r15;√r15→r16
202: "u'i":r16-r1/r16*(r14r11+r13r10)→r17
203: "v'":r1/r16*(r13r11-r14r10)→r18
204: "bar u'v'":r17r18+C[220+B]→C[220+B]
205: "u'2":r17r17+C[210+B]→C[210+B]
206: "v'2":r18r18+C[215+B]→C[215+B]
207: r1+C[200+B]→C[200+B];r1r1+C[B+205]→C[B+205]
208: "PRYRONOMETER":
209: if B=4;r36+r37→r37;R+1→R
210: ret
211: "              ---------------":
212: "WRITE":
213: cfg 5;fxd 0
214: str(E)→D$;D$[2,4]→B$[1,3]
215: int(W/3600)→A;str(A)→D$[1,3];"00"→D$[4,5]
216: if A<10;"0"→D$[1,1];D$[1,2]→B$[4,5];jmp 2
217: D$[2,5]→B$[4,7]
218: "00"→B$[6,7]
219: B$[1,7]→D$[1,7];"00"→B$[7,8]
220: for I=1 to 5
221: if D[I]<30;-999→D[I]*-.0001→C[I]→C[I+5]→C[I+10];jmp 3
222: C[I]/D[I]→C[I]
223: √((C[I+5]-C[I]↑2D[I])/(D[I]-1))→C[I+10];√(C[I+5]/D[I])→C[I+5]
224: if D[I+5]<30;-999→D[I+5]*-.0001→C[I+30]→C[I+35]→C[I+40];jmp 3
225: C[I+30]/D[I+5]→C[I+30]
226: √((C[I+35]-C[I+30]↑2D[I+5])/(D[I+5]-1))→C[I+40];√(C[I+35]/D[I+5])→C[I+35]
227: if D[I+10]<30;-999→D[I+10]*-.0001→C[I+60]→C[I+65]→C[I+70];jmp 3
228: C[I+60]/D[I+10]→C[I+60];√((C[I+65]-C[I+60]↑2D[I+10])/(D[I+10]-1))→C[I+70]
229: √(C[I+65]/D[I+10])→C[I+65]
230: if D[I+15]<30;-999→D[I+15]*-.0001→C[I+90]→C[I+95]→C[I+100];jmp 4
231: C[I+90]/D[I+15]→C[I+90]
232: √((C[I+95]-C[I+90]↑2D[I+15])/(D[I+15]-1))→C[I+100]
233: √(C[I+95]/D[I+15])→C[I+95]
234: if D[I+20]<30;-999→D[I+20]*-.0001→C[I+120]→C[I+125]→C[I+130];jmp 4
235: C[I+120]/D[I+20]→C[I+120]
236: √((C[I+125]-C[I+120]↑2D[I+20])/(D[I+20]-1))→C[I+130]
237: √(C[I+125]/D[I+20])→C[I+125]
238: if D[I+25]<30;-999→D[I+25]*-.0001→C[I+150]→C[I+155]→C[I+160];jmp 4
239: C[I+150]/D[I+25]→C[I+150]
240: √((C[I+155]-C[I+150]↑2D[I+25])/(D[I+25]-1))→C[I+160]
241: √(C[I+155]/D[I+25])→C[I+155]
242: D[I+30]→r8
```

```
243: if r8<30;-999+r8*-.0001→C[I+180]→C[I+185]→C[I+190]→C[I+195]
244: if r8<30;-999+r8*-.0001→C[I+200]→C[I+205]→C[I+210]→C[I+215]
245: if r8<30;-999+r8*-.0001→C[I+220];gto 270
246: C[I+195]/r8→C[I+195];C[I+180]/r8→C[I+180]
247: C[I+185]/r8→C[I+185];C[I+190]/r8→C[I+190]
248: C[I+200]/r8→C[I+200];r((C[205+I]-C[200+I]↑2r8)/(r8-1))→C[I+205]
249: C[I+210]/r8→C[I+210];C[I+215]/r8→C[I+215]
250: for J=1 to 2
251: if not flg6;C[195+I]→r22;C[180+I]→r23
252: if not flg6;r(r22*r22+r23*r23)→C[195+I]
253: if flg6;C[185+I]→r22;C[190+I]→r23
254: if r22>0 and r23>0;0→r25
255: if r22>0 and r23<0;180→r25
256: if r22<0 and r23<0;180→r25
257: if r22<0 and r23>0;360→r25
258: if not flg6;r25+atn(r22/r23)→C[180+I]
259: if flg6;r25+atn(r22/r23)→C[185+I]
260: sfg 6
261: next J
262: cfg 6
263: 0→C[190+I]
264: I+290→r20
265: for J=r20 to I by -5
266: abs(G[I]-C[I+130])→r9;if r9>180;360-r9→r9
267: r9*r9+C[190+I]→C[190+I]
268: next J
269: r(C[190+I]/r8)→C[190+I]
270: next I
271: "filters":
272: fxd 0;prt "DAY",E,"HOUR",int(W/3600)
273: prt "RECORDS REJECTED FOR HOUR",r42
274: spc 1
275: for I=1 to 5
276: spc 1
277: fxd 0;prt "      STATION #",I;fxd 4
278: "diff NO-NOX":
279: if C[I+30]<-998;jmp 2
280: if C[I]-C[I+30]>.002;prt "NO>NOX",C[I],C[I+30]
281: if C[I]>-998 and C[I]<-.002;prt "NO  LOW",C[I]
282: if C[I]>.2;prt "NO HIGH",C[I]
283: if C[I+30]>-998 and C[I+30]<-.002;prt "NOX LOW",C[I+30]
284: if C[I+30]>.35;prt "NOX HIGH",C[I+30]
285: "diff CH4-THC":
286: if C[I+90]<-998;jmp 2
287: if C[I+60]-C[I+90]>.02;prt "CH4>THC",C[I+60],C[I+90]
288: if C[I+60]>-998 and C[I+60]<1.2;prt "CH4 LOW",C[I+60]
289: if C[I+60]>6;prt "CH4 HIGH",C[I+60]
290: if C[I+90]>-998 and C[I+90]<1.2;prt "THC LOW",C[I+90]
291: if C[I+90]>6;prt "THC HIGH",C[I+90]
292: if C[I+120]>-998 and C[I+120]<0;prt "CO LOW",C[I+120]
293: if C[I+120]>6;prt "CO HIGH",C[I+120]
294: if C[I+150]>-998 and C[I+150]<0;prt "NEPH LOW",C[I+150]
295: if C[I+150]>10;prt "NEPH HIGH",C[I+150]
296: if C[I+200]>15;prt "WS HIGH",C[I+200]
297: if C[I]<-998;prt "NO OUT",C[I]
298: if C[I+30]<-998;prt "NOX OUT",C[I+30]
299: if C[I+60]<-998;prt "CH4 OUT",C[I+60]
300: if C[I+90]<-998;prt "THC OUT",C[I+90]
301: if C[I+120]<-998;prt "CO OUT",C[I+120]
302: if C[I+150]<-998;prt "NEP OUT",C[I+150]
303: if C[I+185]<0 or C[I+185]>360;prt "WD OUT",C[I+185]
304: if C[I+200]<-998;prt "WS OUT",C[I+200]
305: for J=I to I+25 by 5
306: if H[J]>0;gto 310
307: next J
308: next I
309: gto 322
```

```
310: prt "# REJECT VALUES"
311: fxd 0
312: if H[I]>0;prt "NO",H[I]
313: if H[I+5]>0;prt "NOX",H[I+5]
314: if H[I+10]>0;prt "CH4",H[I+10]
315: if H[I+15]>0;prt "THC",H[I+15]
316: if H[I+20]>0;prt "CO",H[I+20]
317: if H[I+25]>0;prt "NEPH",H[I+25]
318: if H[I+30]>0;prt "WS WD",H[I+30]
319: fxd 4
320: spc 2
321: next I
322: spc 1
323: "end filters":
324: "END CK":
325: "pryo day sumation":if R<30;-999→r37→r38;1→r39;jmp 2
326: r37/R*60→r37;r37+r38→r38
327: if r39=1;-999→r38
328: "END AQ AV":
329: if F[1]+F[7]+F[12]+F[13]+F[19]+F[25]=0;gto "DF"
330: for I=1 to 5
331: E[I]-F[I]→C[I+25]
332: E[I+5]-F[I+5]→C[I+55]
333: E[I+10]-F[I+10]→C[I+85]
334: E[I+15]-F[I+15]→C[I+115]
335: E[I+20]-F[I+20]→C[I+145]
336: E[I+25]-F[I+25]→C[I+175]
337: next I
338: fmt 1,z,c259
339: fmt 2,z,c235
340: fmt 3,z,c8
341: fmt 4,z,c90
342: fmt 5,z,2f9.4
343: fmt 6,z,f9.4
344: fmt 7,z,c72
345: wti 0,3
346: for I=1 to 5
347: str(I)→D$[8,10];D$[9,9]→D$[8,8];wrt 3.3,D$[1,8]
348: for J=0 to 225 by 5;wrt 3.6,C[I+J];next J
349: if I=4;wrt 3.5,r37,r38
350: if I#4;wrt 3.4,E$[1,90]
351: if I=4;wrt 3.7,E$[1,72]
352: wait 10
353: wti 6,177000;wti 6,177400
354: next I
355: "TO PRINT EACH RECORD, STORE  jmp 2  AFTER THE COLON":
356: "PRINT BYPASS":gto 364
357: for I=1 to 5
358: str(I)→D$[8,10];D$[9,9]→D$[8,8]
359: prt D$[1,8];fxd 4
360: for J=0 to 225 by 5
361: prt C[I+J]
362: next J
363: next I
364: for I=1 to 230;0→C[I];next I
365: for I=1 to 35;0→D[I];next I
366: for I=15 to 165 by 30
367: for J=1 to 5
368: 999→C[I+J]
369: next J
370: next I
371: for I=1 to 30;0→H[I];next I
372: 0→r37→r42→R
373: wti 0,2
374: ret
375: "ERROR":cfg 9;wti 0,3;wti 6,177400
```

```
376:
377: if rom=69;if ern=5;if erl=39;buf "A";gto 39
378: if rom=69;if ern=5;if erl=43;buf "A";gto 78
379: if rom=0;if ern>40 and ern<66;dsp "CARTRIDGE DECK DOWN";stp
380: if rom=0;if ern=15;dsp "PRINTER OUT OF PAPER, OR DOWN";stp
381: prt A$[4,9],rom,ern,erl;cfg 9
382: stp
383: buf "A";gto 39
384: dsp "HELP! call a human! HELP!";beep;wait 1000;stp
385: "END":
386: fxd 0;dsp "TAPE",E,"COMPLETE       -RUN-";beep;wait 750;beep;wait 750;beep
387: stp
388: "DF":
389: for J=25 to 175 by 30
390: for I=1 to 5
391: -999→C[I+J]
392: next I
393: next J
394: for I=1 to 30;E[I]→F[I];next I
395: gto 338
396: "T":wti 0,2
397: if S=1;val(A$[5,10])→r47;2→S;7→r50;0→r49
398: r50-1→r50
399: if r50<=3;167400→Z
400: if r50>3;173400→Z
401:
402:
403: if r50=6;gto 78
404: if r50>2;val(A$[5,10])+r49→r49
405: if r50=3;r49/3→r49;if r49>r47+150 or r49<r47;1→r49
406: if r50=1;if r49=1;0→S→r50;spc 2;prt "BAD RECORD AT",r47;173400→Z;gto 76
407: if r50=0;0→S;173400→Z;ret
408: gto 78
```

L. 59-60	Test if record time is less than start time 1
L. 62-68	Tests for end of hour
L. 70	If end of tape go to "END" or end of stop time 2
L. 73-74	If end of stop time 1, rewind tape, display message Stop
L. 76	If end of hour, go to subroutine "WRITE"
L. 77	Go to subroutine "C"
L. 78	Clear buffer
L. 79	Error recovery, go to subroutine ERROR End of mainline
L. 80	End of interrupt service routine
L. 81	Start of subroutine "C"
L. 82	Extract total time into seconds = X
L. 83	C = NO value D = NO thumbwheel
L. 84	F = NO_x value G = NO_x thumbwheel
L. 85	H = CH_4 value K = CH_4 thumbwheel
L. 86	L = THC value M = THC thumbwheel
L. 87	N = CO value O = CO thumbwheel
L. 88	R_1 = Wind speed value R_2 = Wind speed thumbwheel
L. 89	R_3 = Wind direction value R_4 = Wind direction thumbwheel
L. 90	T = NEPH value U = NEPH thumbwheel
L. 91	Pyranometer value into units = R36

L. 92-101	Utility routine to print single value P = Station No. If Q = 1 - NO 2 - NO_x 3 - CH_4 4 - THC 5 - CO 6 - NEPH 7 - WS 8 - WD

NO Routine

L. 102-105	Valid thumbwheel check
L. 106-107	Filter to reject absurd values
L. 108-110	Increment counter ΣNO ΣNO^2
L. 111	Last value of hour Minimum and maximum value determination

NO_x Routine

L. 114-118	Valid thumwheel check
L. 119	Filter to reject absurd values
L. 121	Counter
L. 122	ΣNO_x
L. 123	$\Sigma NO_x{}^2$
L. 124	Last value for hour
L. 125-126	Minimum and maximum value determination

CH_4 Routine

L. 130	Valid thumbwheel check
L. 132	Filter to reject absurd values
L. 134	Increment counter
L. 135	ΣCH_4
L. 136	$\Sigma CH_4{}^2$
L. 137	Last value of hour

L. 138-139	Minimum and maximum value determination
THC Routine	
L. 143	Valid thumbwheel check
L. 145	Filter to reject absurd values
L. 147	Increment counter
L. 148	ΣTHC
L. 149	ΣTHC^2
L. 150	Last value of hour
L. 151-152	Minimum and maximum value determination
CO Routine	
L. 156	Valid thumbwheel check
L. 158	Filter to reject absurd values
L. 160	Increment counter
L. 161	ΣCO
L. 162	ΣCO^2
L. 163	Last value of hour
L. 164-165	Minimum and maximum value determination
NEPH Routine	
L. 169	Valid thumbwheel check
L. 171	Filter to reject absurd values
L. 173	Increment counter
L. 174	$\Sigma NEPH$
L. 175	$\Sigma NEPH^2$
L. 176	Last value of hour
L. 177-178	Minimum and maximum value determination
Wind Speed & Wind Azimuth Routine	
L. 181	Valid thumbwheel check
L. 185-186	Filter to reject absurd values

L. 187	Volts correction into degrees and meters per second
L. 188	Increment
L. 189-192	Store wind azimuth values into array G[*]
L. 193-196	$r_{10} = \sin\theta_i$ $r_{11} = \cos\theta_i$ $\Sigma v_i \sin\theta_i = \Sigma V_x$ $\Sigma v_i \cos\theta_i = \Sigma V_y$ $\Sigma \sin\theta_i$ $\Sigma \cos\theta_i$
L. 197	V_{xi} Calculation $r13 = \bar{V}_{xi} = (2\bar{V}_{xi-1} - \bar{V}_{xi-2}) \cdot 85 + (0.15) V_i \sin\theta_i$
L. 199	V_{yi} $r14 = \bar{V}_{yi} = (2\bar{V}_{yi-1} - V_{yi-2}) \cdot 85 + (0.15) v_i \cos\theta_i$
L. 201	$r15 = \bar{V}_i{}^2 = \bar{V}_{xi}{}^2 + V_{yi}{}^2; \quad \bar{V}_i{}^2 = \bar{V}_i = r16$
L. 202	$r17 = u'i = v_{i/\bar{V}i} (\bar{V}_{yi} \cos\theta_{i+} \bar{V}_{xi} \sin\theta_i)$
L. 203	$r18 = v_i = v_{i/\bar{V}_i} (\bar{V}_{xi} \cos\theta_i \bar{V}_{yi} \sin\theta_i)$
L. 204	$\Sigma u'v'$
L. 205	$\Sigma u'^2$
L. 206	Σv^2 stored in C[216-220]
L. 207	Σv_i stored in C[201-205] Σv_i^2 stored in C[206-210]
L. 208-209	Σ Pyranometer
L. 210-211	Return from subroutine "C"
L. 212-213	Header Clear write subroutine f1

L. 214-219 Manipulations for ID header to be written on tape

DAY	HOUR	MIN
NNN	NN	00

Begin write and averaging routine

L. 220-221 Statistical test for NO

If number of readings is less than 30, then -.00XX is entered for mean, RMS and where XX is the number of reading for the hour.

L. 222 $\bar{X}\ NO = 1/n\sum_{i=1}^{n} x$

L. 223 $\sigma NO = \sqrt{\frac{\sum^{n} x_i^{2}-(x)^{2}}{n-1}}$

$RMS = \sqrt{1/n \sum^{n} x_i^{2}}$

L. 224 Statistical test for NO_x

L. 225 $\bar{X}\ NO_x$

L. 226 $\sigma\ NO_x$

RMS_{NO_x}

L. 227 Statistical test for CH_4

L. 228 $\bar{x}\ CH_4$

$\sigma\ CH_4$

L. 229 RMS_{CH_4}

L. 230 Statistical test for THC

L. 231 $\bar{x}$ THC

L. 232 σ THC

L. 233	RMS_{THC}
L. 234	Statistical test for CO
L. 235	$\bar{x}$ CO
L. 236	σ CO
L. 237	RMS_{CO}
L. 238	Statistical test for NEPH
L. 239	$\bar{x}$ NEPH
L. 240	σ NEPH
L. 241	RMS_{NEPH}
L. 242	r^8 = number of WS, WD readings
L. 243-245	WS, WD calculations Statistical tests
L. 246	$\bar{V}_x = 1/n\Sigma V_x$ $\bar{V}_y = 1/n\Sigma V_y$
L. 247	$\sin\theta = 1/n\Sigma\sin\theta_i$ $\cos\theta = 1/n\Sigma\cos\theta_i$
L. 248	$\bar{v}_i = ws = 1/n\Sigma v_i$ $\sigma ws = \sqrt{\frac{\Sigma v_i^2 - n(\bar{v}_i)^2}{n-1}}$
L. 249	$\bar{u}' = 1/n\Sigma\ u'^2$ $\bar{v}'^2 = 1/n\Sigma\ v'^2$
L. 250	Routine using the ATN function for correct quadrant
L. 251	$r22 = \bar{V}_x$ $r23 = \bar{V}_y$
L. 252	$V_{mws} = \sqrt{\bar{V}_x^2 + \bar{V}_y^2}$
L. 253	$r22 = \sin\theta$ $r23 = \cos\theta$

L. 254-257	r25 = Quadrant correction
L. 258-259	WD = atn (sinθ/cosθ) $WD = \text{atn}\,(\overline{\frac{\sin\theta}{\cos\theta}})$
L. 264	r20 = Constant looping factor
L. 265-268	$D_i = \lvert WD_i - WD \rvert$: D_i always < 180° $\sum_{i=1}^{n} D_i$
L. 269	σWD calculation $\sigma WD = \sqrt{\sum_{i=1}^{n} \frac{D_i^2}{n}}$
L. 270	End averaging loop
L. 271-323	Filters operator notes
L. 310	Print number of rejected values in mainline read
L. 323	End of filters
L. 325-327	r37 = Hour Pyro 24 hours r38 = Day Pyro
L. 328	End air quality averaging
L. 329	Test for first hour of processing for last record of hour difference
L. 330-337	Last observed concentration minus last observed concentration from previous hour calculations $x_n - x_o$ Calculations E[*] = Last observed F[*] = Previous hour last observed
L. 338-344	Format statements
L. 345	Prepare to use interface number 3
L. 347	Write data routine Add station No. to header and write same

L. 348	Write data for respective station number
L. 350-351	Write blanks to make record = 511 characters
L. 352	IRG command to tape deck
L. 354	End write
L. 355	Print data utility
	End utility
L. 364	Zero data summation array, C[*]
L. 365	Zero number of records counter array, D[*]
L. 366-370	Fill minimum value locations of data array with 999
L. 371	Zero number of bad records counter array, H[*]
L. 372	Zero pyranometer for hour
L. 373	Prepare to use interface #2
L. 374	Return End of write routine
L. 375	Error recovery utility
L. 385	End of tape routine
L. 386	End of tape audio-visual message
L. 388	$X_n - X_o$ first hour routine
L. 391	$-999 \rightarrow X_n - X_o$ locations on C[*]
L. 394	$X_n - X_o$
	Cosmetic "END"

Tabular Summaries Software

```
.TABLE
.NOLIST
.NOENDMSG
.NOSCAN
.REM. PROCEDURE : TABLE
.REM.
.REM. AUTHOR    : M. J. LIPPOLD .77/07/27.
.REM.
.REM. SECTION   : SSD/LV
.REM.
.REM. FUNCTION  : THIS PROCEDURE IS DESIGNED TO PROVIDE THE USER
.REM.             WITH THE CAPABILITY OF PRINTING HOUR AVERAGES TABLES
.REM.             FOR WAFB DATA.
.REM.
.REM.               THIS PROCEDURE IS TOTALLY INTERACTIVE.
.REM.
.REM. EXAMPLES :
.REM.
.REM.             IF PROCFIL IS A LOCAL FILE, THEN USE
.REM.
.REM.                CALL (TABLE)
.REM.
.REM.             IF PROCFIL IS NOT A LOCAL FILE, USE
.REM.
.REM.                CALLX (CALL,*LECMJL,P=TABLE)
.REM.
.REM.
.SCAN
.SCOPE($CONNECT(INPUT,OUTPUT)$)
.FSET(INPUT,EOR=OSHIT,EOF=OSHIT)
.*  WAFB HOUR AVERAGES TABLE GENERATOR
.*
.*  ROUTE CARD PRIORITY (4 DIGITS) \:
.FREAD(PPI)
.*  ENTER THE PF NAME OF THE DATA FILE \:
.FREAD(NAME)
.*  ENTER THE MONTH (1 TO 12) \:
.FREAD(MONTH)
.*  ENTER THE YEAR (76 OR 77) \:
.FREAD(YEAR)
.TEXT(TAB)
NJTAB,T1000,P0.BEPAUAF,NWAFB.
MAP,OFF.
REWIND(OUTPUT)
ATTACH(TAPE8,'NAME',ID=NSIWAFB)
REWIND(TAPE8)
FTN,L=0,OPT=2.
.NOSCAN
LGO.
EXIT(U)
RETURN(TAPE1,TAPE2,TAPE3,TAPE4,TAPE5,TAPE8)
DISPOSE,OUTPUT.
DUP(2,3).
REWIND,TAPE9.
COPYBF,TAPE9,OUTPUT.
REWIND(TAPE9)
REQUEST(PRINT,*PF)
ACOPY(TAPE9,PRINT)
.SCAN
CATALOG(PRINT,'NAME'PRINTFILE,ID=NSIWAFB,RP=999)
.NOSCAN
.TEXT(TAB)
      PROGRAM RPT2(INPUT,OUTPUT,TAPE1,TAPE2,TAPE3,TAPE4,TAPE5,
     +TAPE6=INPUT,TAPE7=OUTPUT,TAPE8=/510,TAPE9)
      DIMENSION XLINE(9),AMX(9,31),TPN(9,3),IFU(9)
      DIMENSION TAB(9,31,24),AVG(9,31),IHOUR(24)
      DIMENSION IFMT(2),JFMT(9)
      DIMENSION AVGHOU(9,24),XMHOUR(9,24)
      INTEGER DXD(12),CXD(13,2)
      DATA (DXD(I),I=1,12)/10H JANUARY  ,10H FEBRUARY ,10H  MARCH   ,
     +10H  APRIL   ,10H   MAY    ,10H   JUNE   ,10H   JULY   ,
     +10H  AUGUST  ,10HSEPTEMBER ,10H OCTOBER  ,10H NOVEMBER ,
     +10H DECEMBER /
      DATA (CXD(I,1),I=1,13)/0,31,59,90,120,151,181,212,243,273,304,334,
     +365/
      DATA (CXD(I,2),I=1,13)/0,31,60,91,121,152,182,213,244,274,305,335,
     +366/
***
*   THIS ROUTINE IS DESIGNED TO PRODUCE TABLES OF HOUR AVERAGES DATA
*   FOR THE WILLIAMS AIR FORCE BASE PROJECT. THE DESIGN IS SET UP
*   TO HANDLE FIVE STATIONS (EACH HAVING SEVEN PARAMETERS).
*   (77/06/01)  M. J. LIPPOLD -LOCKHEED ELECTRONICS CO., INC.
***
*   MODIFICATION 1:  REQUEST ADDITIONAL TABLE TO SHOW * THC-CH4 *
*   (77/06/13)  M. J. LIPPOLD -LOCKHEED ELECTRONICS CO., INC.
***
*   MODIFICATION 2:  REQUEST AVG AND MAX SHOWN FOR EACH DAY
*   (77/06/30)  M. J. LIPPOLD -LOCKHEED ELECTRONICS CO., INC.
***
*   MODIFICATION 3:  REQUEST FILTERING OF DATA VALUES
*   (77/06/20)  M. J. LIPPOLD -LOCKHEED ELECTRONICS CO., INC.
*
      DO 67 LS=1,24,1
      IHOUR(LS) = LS - 1
   67 CONTINUE
*
*   SET UP CONTROL PARAMETERS AND THE TITLE ARRAYS
*
.SCAN
      IYEAR = 19'YEAR'
      IYFLG = 1
      IF(IYEAR.EQ.1976) IYFLG = 2
      IMONTH = DXD('MONTH')
      NDAYS = CXD('MONTH'+1,IYFLG) - CXD('MONTH',IYFLG)
      IDS = CXD('MONTH',IYFLG)
.NOSCAN
      IFMT(1)=10H(1H0,I2,
      IFMT(2)=10H
      IPN(1,1)=10H         N
      IPN(1,2)=10HITRIC OXID
      IPN(1,3)=10HE
      IPN(2,1)=10H      OXID
      IPN(2,2)=10HES OF NITR
      IPN(2,3)=10HOGEN
      IPN(3,1)=10H
      IPN(3,2)=10H  METHANE
      IPN(3,3)=10H
      IPN(4,1)=10H      TOTA
      IPN(4,2)=10HL HYDROCAR
      IPN(4,3)=10HBONS
      IPN(5,1)=10H       CAR
      IPN(5,2)=10HBON MONOXI
      IPN(5,3)=10HDE
      IPN(6,1)=10H         N
      IPN(6,2)=10HEPHELOMETE
      IPN(6,3)=10HR
      IPN(7,1)=10H  VECTOR M
      IPN(7,2)=10HEAN WIND D
      IPN(7,3)=10HIRECTION
      IPN(8,1)=10H    VECTOR
      IPN(8,2)=10H MEAN WIND
      IPN(8,3)=10H SPEED
      IPN(9,1)=10HTOTAL HYDR
      IPN(9,2)=10HOCARBONS -
      IPN(9,3)=10H METHANE
      IPU(1)=10H(PPB)
      IPU(2)=10H(PPB)
      IPU(3)=10H(PPM)
      IPU(4)=10H(PPM)
      IPU(5)=10H(PPM)
      IPU(6)=10H(M**-1)
      IPU(7)=10H(DEGREES)
      IPU(8)=10H(M/SEC)
      IPU(9)=10H(PPM)
      JFMT(1)=10H26(F5.1))
      JFMT(2)=10H26(F5.1))
      JFMT(3)=10H26(F5.2))
      JFMT(4)=10H26(F5.2))
      JFMT(5)=10H26(F5.2))
      JFMT(6)=10H26(F5.1))
      JFMT(7)=10H26(F5.0))
      JFMT(8)=10H26(F5.2))
      JFMT(9)=10H26(F5.2))
*
*   INPUT IS ASSUMED TO BE ON TAPE 8. TAPES 1-5 ARE USED AS
*   SCRATCH FILES. TAPE 9 IS THE OUTPUT FILE.
*
    4 READ(8,3)IDAY,IHR,IMN,ITR,(XLINE(I),I=1,8)
    3 FORMAT(I3,2I2,I1,6(F9.4,45X),F9.4,18X,F9.4)
      IF(EOF(8))9,5
*
*   CONVERT NO AND NOX TO PPB.
*
    5 XLINE(1)=XLINE(1)*1000.00
      XLINE(2)=XLINE(2)*1000.00
      IF(XLINE(3).LT.0.0) XLINE(3)=XLINE(3)-1.0
      DO 6 I=1,8,1
      IF(XLINE(I).LE.-8.0) XLINE(I)=-9.9
      IF(XLINE(I).GT.999.9) XLINE(I)=-9.9
    6 CONTINUE
      IF(XLINE(7).LT.0)XLINE(7)=-9.0
      IF(XLINE(8).GT.50.0)XLINE(8)=-9.9
*
*   CHECK THE DAY RANGES.
*
      IF(IDAY.LE.IDS)IDAY=IOLD
      IF(IDAY.GT.IDS+32)IDAY=IOLD
      IOLD=IDAY
*
*   COMPUTE THC - CH4
*
      XLINE(9)=-9.9
      XTLN=ALINE(4)-XLINE(3)
      IF((XLINE(4).NE.-9.9).AND.(XLINE(3).NE.-9.9)) XLINE(9)=XTLN
*
*   WRITE ON THE APPROPRIATE SCRATCH FILE.
*
      WRITE(ITR,7)IDAY,IHR,IMN,ITR,(XLINE(I),I=1,9)
    7 FORMAT(1X,I3,2I2.2,I1,9(F9.4,1X))
      GOTO 4
*
*   REWIND SCRATCH FILES
*
    9 DO 8 I=1,5,1
      REWIND I
    8 CONTINUE
*
```

```
  110 CONTINUE
  100 CONTINUE
*
*   COMPUTE HOUR AVG AND MAX.
*
      DO 120 I1=1,9,1
      DO 130 I3=1,24,1
      N=0
      AT=0.0
      XT=-9.0
      DO 140 I2=1,NDAYS,1
      IF(TAB(I1,I2,I3).LE.-8.0) GO TO 140
      IF(TAB(I1,I2,I3).GE.XT) XT=TAB(I1,I2,I3)
      N=N+1
      AT=AT+TAB(I1,I2,I3)
  140 CONTINUE
      ATYN=-9.0
      IF(N.GT.0) ATYN=AT/N
      AVGHOU(I1,I3)=ATYN
      XMHOUR(I1,I3)=XT
  130 CONTINUE
  120 CONTINUE
*
*   NOW OUTPUT THE APPROPIATE TABLE...
*
      WRITE(9,300)
  300 FORMAT(*T*)
      DO 50 J=1,9,1
      WRITE(9,10)
      WRITE(9,11)I,(IPN(J,L3),L3=1,3),IPU(J),IMONTH,IYEAR
      WRITE(9,12)(IHOUR(L4),L4=1,24)
      WRITE(9,13)
      PRCT = 0.0
      IPCNT = 0
      IFMT(2)=JFMT(J)
   11 FORMAT((11X,*TRAILER *,I4,T54,4A10,20X,A10,1X,I4/)
      DO 51 K=1,NDAYS,1
      DO 70 L=1,24,1
      IF(TAB(J,K,L).LE.-8.0) IPCNT = IPCNT + 1
      IF((J.EQ.7).AND.(TAB(J,K,L).EQ.999.)) IPCNT = IPCNT + 1
   70 CONTINUE
      IF(J.EQ.7) GOTO 75
      IF((AVG(J,K).GT.-8.0).AND.(XMX(J,K).GT.-8.0))GOTO 88
   75 WRITE(9,IFMT)K,(TAB(J,K,L),L=1,24)
      GOTO 51
   88 WRITE(9,IFMT)K,(TAB(J,K,L),L=1,24),AVG(J,K),XMX(J,K)
*
*   LOOP FOR NEXT DAY ...
*
  51  CONTINUE
      IF(J.EQ.7) GO TO 170
      IF(J.EQ.3.OR.J.EQ.4.OR.J.EQ.5) GO TO 161
      IF(J.EQ.8.OR.J.EQ.9) GO TO 161
      WRITE(9,160)(AVGHOU(J,K),K=1,24),(XMHOUR(J,K),K=1,24)
  160 FORMAT(/* AVG*,F4.1,23F5.1,//,* MAX*,F4.1,23F5.1)
      GO TO 170
  161 WRITE(9,162)(AVGHOU(J,K),K=1,24),(XMHOUR(J,K),K=1,24)
  162 FORMAT(/* AVG*F4.2,23F5.2,//,* MAX*,F4.2,23F5.2)
*
*   COMPUTE AND OUTPUT PERCENTAGE OF BAD DATA ...
*
  170 PRCT = (IPCNT / (NDAYS * 24.0)) * 100.00
      WRITE(9,71) PRCT
   71 FORMAT(//,2X,F10.4,* PERCENT OF DATA IN ABOVE TABLE IS *
     +*IRRECOVERABLE.*)
*
```

```
*   LOOP FOR NEXT TABLE...
*
   50 CONTINUE
*
*   LOOP FOR NEXT STATION...
*
   20 CONTINUE
      STOP
*
*   ALAS MY FRIEND, OUR AFFAIR HAS REACHED AN
      END
.SCAN
.TEXT(TAB)
.ENDTEXT(TAB)
.*  DO YOU WANT TO SEND IT OFF NOW \:
.FREAD(ANS)
.IF('ANS'=YES)
ROUTE(TAB,DC=IN,TID=C,PRI='PRI')
.ENDIF
.ENDPROC
.ENTRY(OSHIT)
.ENDPROC
```

APPENDIX J

PROCEDURE FOR ACOUSTIC SOUNDER DATA REDUCTION AT WILLIAMS AIR FORCE BASE

Meteorological data required for input to the AQAM Gaussian formulation are WS, WD, mixing depth, and stability class. The AQAM model computes these parameters using WABAN data files. WABAN data recorded on the Form 10 report the hourly meteorological observations from which parameters are developed for the model. A critical portion of this process is the interpolation of data points from the WABAN form since the codes used are not direct meteorological measurements and therefore may not be representative.

For these reasons, redundant meteorological data to provide more direct observation of mixing depth (and somewhat less direct information on stability) were provided with the use of the Aerovironment Acoustic Sounder. This device can be used to get continuous information about the mixing depth to provide data on the dispersion of pollutants in the lowest kilometer of the atmosphere.

The Aerovironment Model 300 used at WAFB was a monostatic acoustic radar (transmitter and receiver use the same antenra) that emits a sound pulse upward and listens for the echo return of the pulse as it is reflected from turbulence regions in the first 500 m aloft. It plots the echo return (in proportion to height) on a recording chart every few seconds, creating on the chart a continuous picture of the atmospheric conditions above the device.

INTERPRETING ECHO RETURN SIGNAL

An understanding of the turbulence type and meteorological conditions responsible for the echo returns is necessary to correlate these data to the computer calculations of mixing depth made from WABAN observations. A monostatic acoustic radar listens to the acoustic energy scattered at a 180° angle. Temperature inhomogeneities in the atmosphere are responsible for 180° backscatter of the transmitted 1600-HZ pulse of energy.

A short study was conducted by EMSL-LV personnel on October 23, 24, and 25, 1976, to obtain side-by-side measurements with a tethered balloon and acoustic sounder. The study consisted of: 1) low-level atmospheric temperature profiles, and 2) winds-aloft measurements using pilot balloons (pibals). These data aided in interpreting acoustic sounder charts and refining the coding technique that appeared on the WABAN meteorology tape transmitted to ANL.

Pibals were standard single-theodolite, North-Star-aligned, 30-g balloon observations of 10-minute duration. Radiosonde data height computations were produced by integrating the hydrostatic equation using a Hewlett-Packard calculator system.

The temperature data were acquired utilizing an Airco tethered balloon and winch system in conjunction with a Buekers Model 4700 telemetry receiving and recording system and a VIZ radiosonde. In the radiosonde, pressure was determined by a baroswitch that was activated by an aneroid capsule. This arrangement was calibrated to ambient pressure through reference to a portable aneroid barometer, which in turn had been calibrated to the mercurial barometer at the Williams weather office, approximately 900 m from the site of the soundings. When properly calibrated, the baroswitch yields information accurate to 1 millibar. Temperature was measured by a thermistor, which is accurate to 0.1°C. The element used during the Williams soundings was referred to as an Accu-lok sensor; it is precalibrated so that a known temperature value is associated with a specific resistance, which eliminates the necessity of a baseline calibration procedure. The life span of an element is effectively unlimited, providing its protective coating is not cracked or soiled.

By comparing analyzed temperature data taken from tethered balloon soundings to acoustic echo return on the recorder chart, the coding technique used for the acoustic sounder data was tested. Agreement between a stable radiation inversion (at indicated height) and changes in the in situ vertical temperature field from tethered balloon measurements was favorable. In this way, EMSL-LV combined two atmospheric profile measuring devices to help extract additional information (over a limited time) on stability and mixing heights. The meteorological data essential to the AQAM model can be compared to a continuous record from the acoustic sounder.

ACOUSTIC SOUNDER CHART ANALYSIS

An example analysis is provided to explain the coding technique adopted specifically for WAFB. The vertical range on the conducting chart paper represents 20-500 m AGL. Nominal chart speed was 30.5 mm/h; however, each chart had manually recorded one-hour time marks because chart speed was not always uniform.

Figure J-1 shows the acoustic data returns for two consecutive days in October 1976. The first 24-hour period was cloudy with occasional drizzle. The second night had clear nighttime skies. The acoustic data returns were significantly different on these two occasions. More typical of WAFB was the second night with clear skies.

The code is a 6-digit number for each hour in the format ABm DEn. The extreme right-hand number, n, is the specific phenomenon designation. The following is a list of the phenomena specific to the WAFB study and their code numbers:

1 = Radiation inversion (typical to nighttime desert)

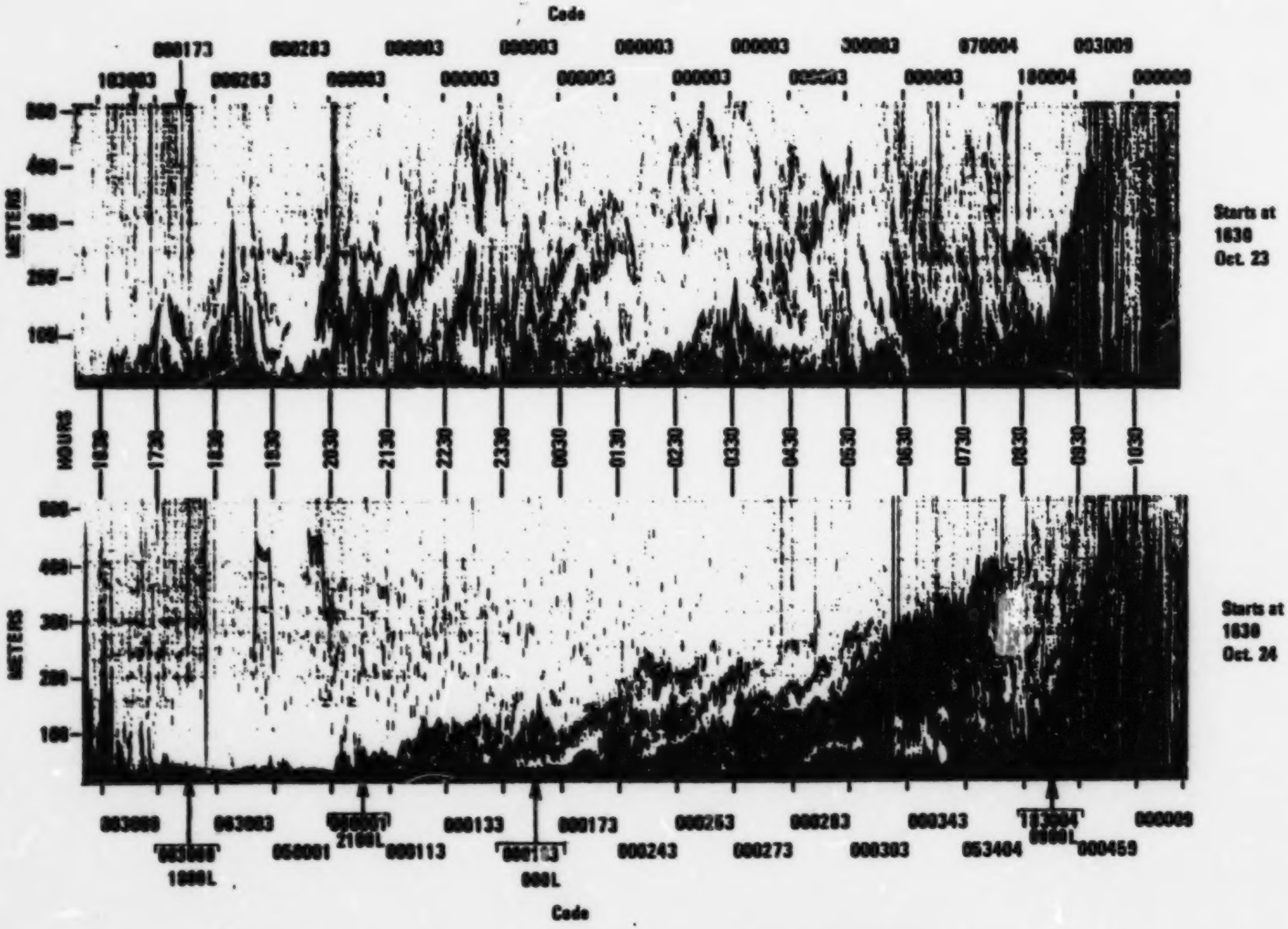


Figure J-1. Example of acoustic sounder chart analysis.

2 = Drainage winds (dense air that flows downhill in mountain-valley terrain)

3 = Layered returns (used when sounding echoes are stratified indicating multiple layers)

4 = Inversion base lifting above ground from morning solar heating (usually limited to 1 or 2 hours at WAFB)

5 = Subsidence inversion (usually caused by synoptic-scale high pressure over the region)

6 = Frontal inversion

9 = Normal daytime return (alternating light and dark spikes that are defined as hot plumes or thermal spikes; sometimes the top of these plumes were in evidence)

In addition to specific phenomena delineated above with a code number, the third digit, m, was used to further explain effects that might be of use for interpretation. They are:

1 = Superimposed return apparently from noise, possible turbulence, or precipitation

2 = Daytime noise (this is an undetermined graying of the return associated with base activity causing background acoustical noise)

3 = Indicates a transition period (usually used in uncertain sounding return records where the daytime returns were changing to nighttime)

4 = Apparent mechanical turbulence superimposed

The AB and DE designations are always the heights in tens of meters, indicating either the top or bottom of the various layers defined in the n code. The specific use of AB and DE varies with the n phenomenon. An 00 code is used when AB or DE are not determinable. In the case of inoperative equipment, the code 999999 was used.

To better explain the coding technique, Figure J-1 has been annotated with time separations and analyzed average height values. The code for each hour appears in a 6-digit form above each averaged hour with the local time indicated at the bottom. To help the reader understand the approach used, four hours — 1800L, 2100L, 000L, and 0900L -- are explained in greater detail:

1800L: At this time the sun had set and the atmosphere was changing from daytime unstable to nighttime stable. It is not clear whether the returns were diminshing thermals or stable air; therefore code 3 was used in the third digit to indicate the top of the returns are at 60 m. A 9 was used in the sixth digit (n location) to indicate the air was relatively unstable.

2100L: The evening inversion from radiation cooling has started. The 08 in the AB locaion indicated that the average top of the return was at 80 m. The code 1 in the n location indicated radiation inversion.

000L: The echo returns are stratified during this hour, typical for this time of night at WAFB; hence the code number 3 is in the n position indicating layered return. The top of the layer averaged 180 m; hence the code 18 in the CD block.

0900L: The sun has risen and the inversion has started to lift. The code number 4 is placed in the n position. There was an apparent line of demarcation between the stable and unstable air. The air average base of the inversion for this time block was 180 m; hence 18 is coded in the AB location. The echoes extend off the chart, so 00 is used in DE to indicate unknown height.

APPENDIX K

CUMULATIVE FREQUENCY DISTRIBUTIONS

WAFB Hourly Averages For Parameters Measured Between July 1976 and June 1977

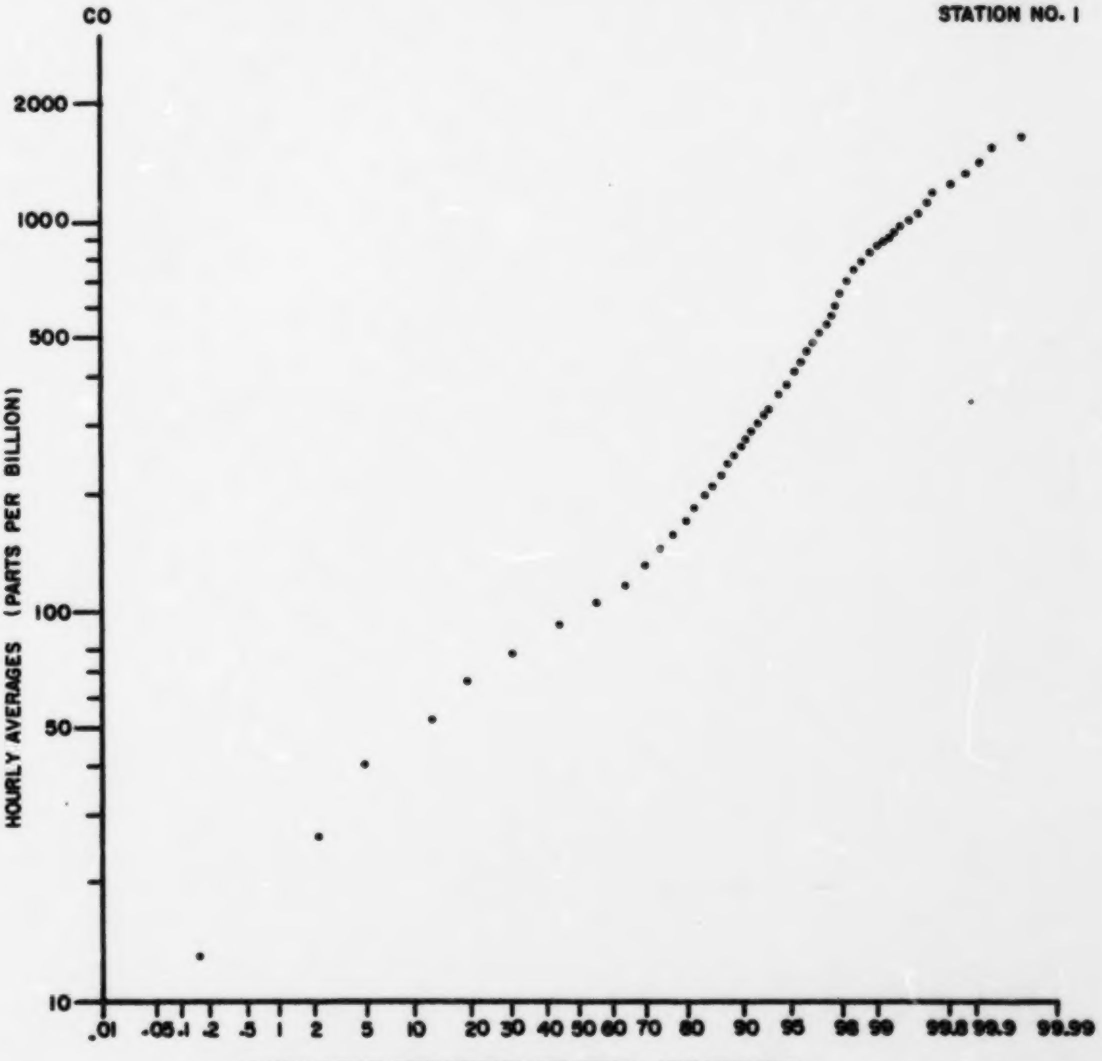


Figure K-1. Yearly cumulative frequency distribution for CO, station 1.

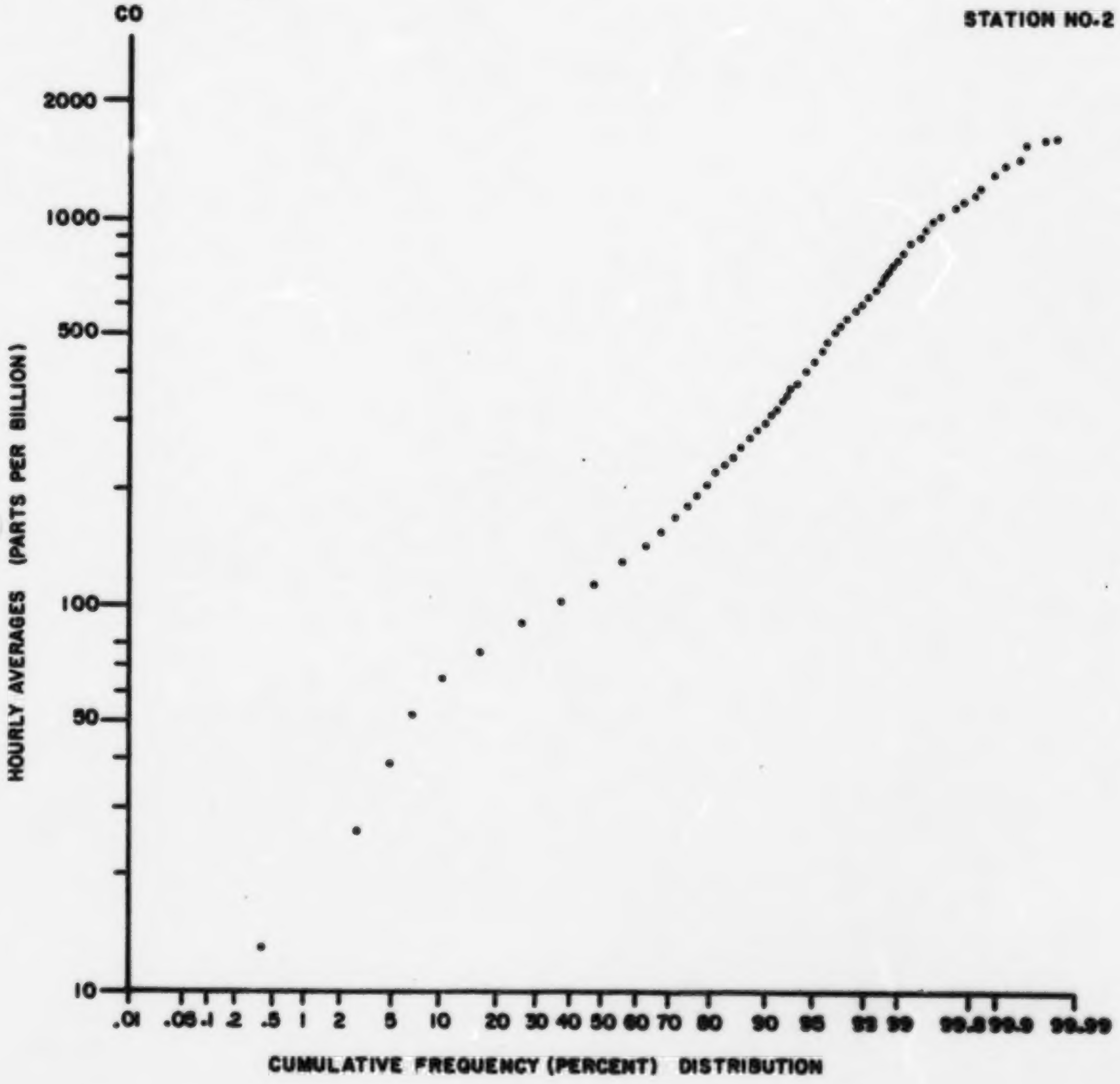


Figure K-2. Yearly cumulative frequency distribution for CO, station 2.

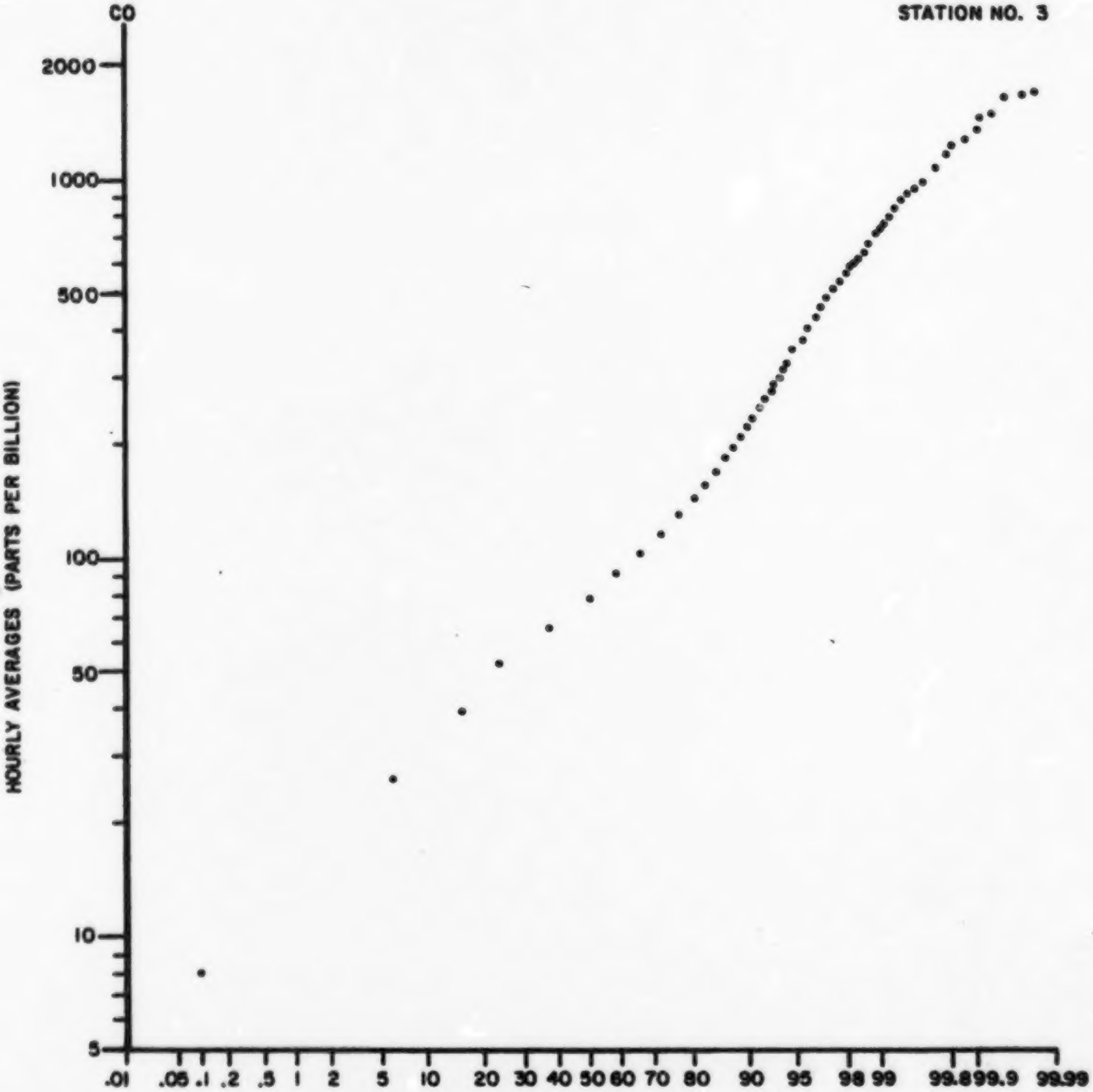


Figure K-3. Yearly cumulative frequency distribution for CO, station 3.

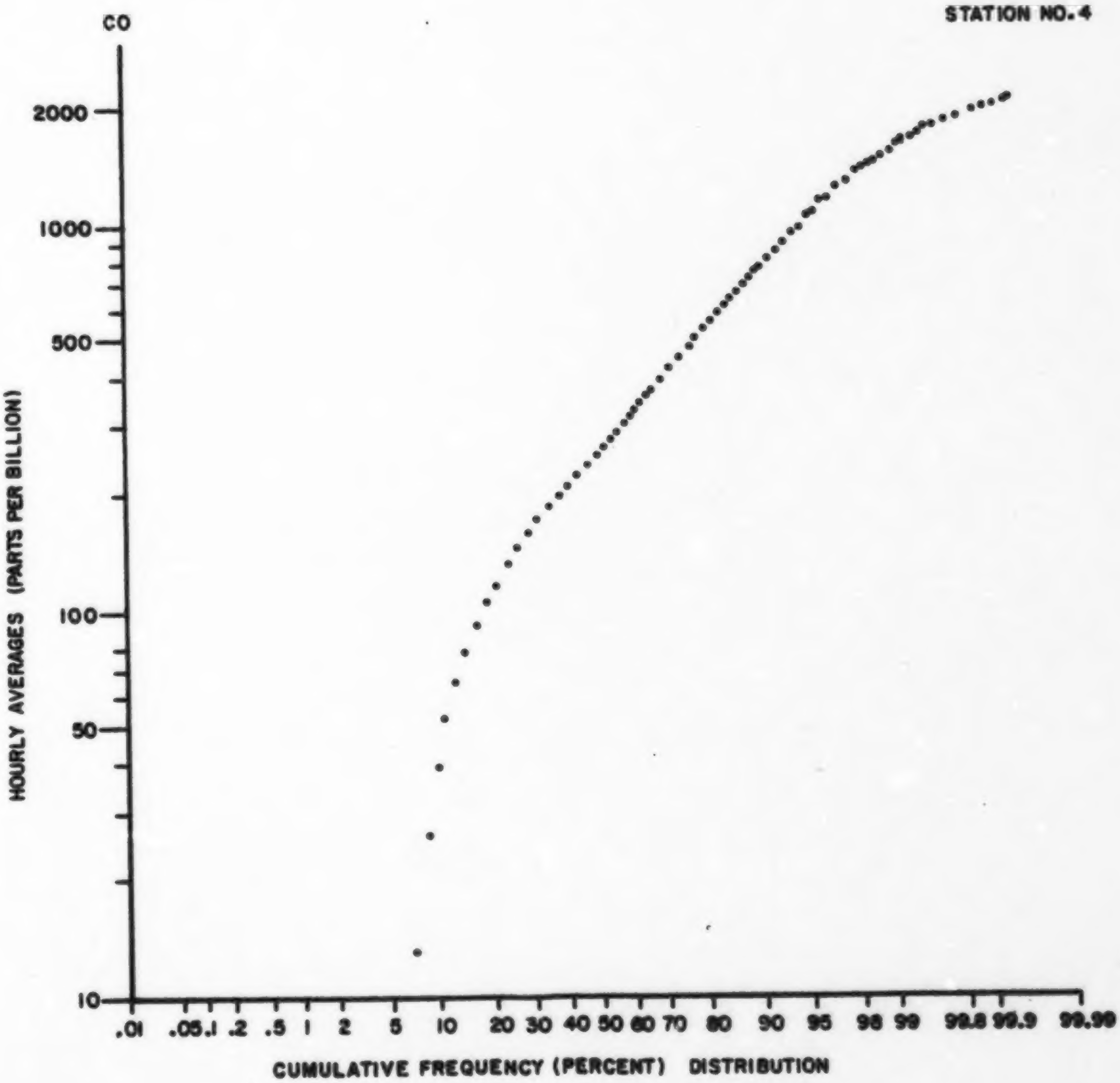


Figure K-4. Yearly cumulative frequency distribution for CO, station 4.

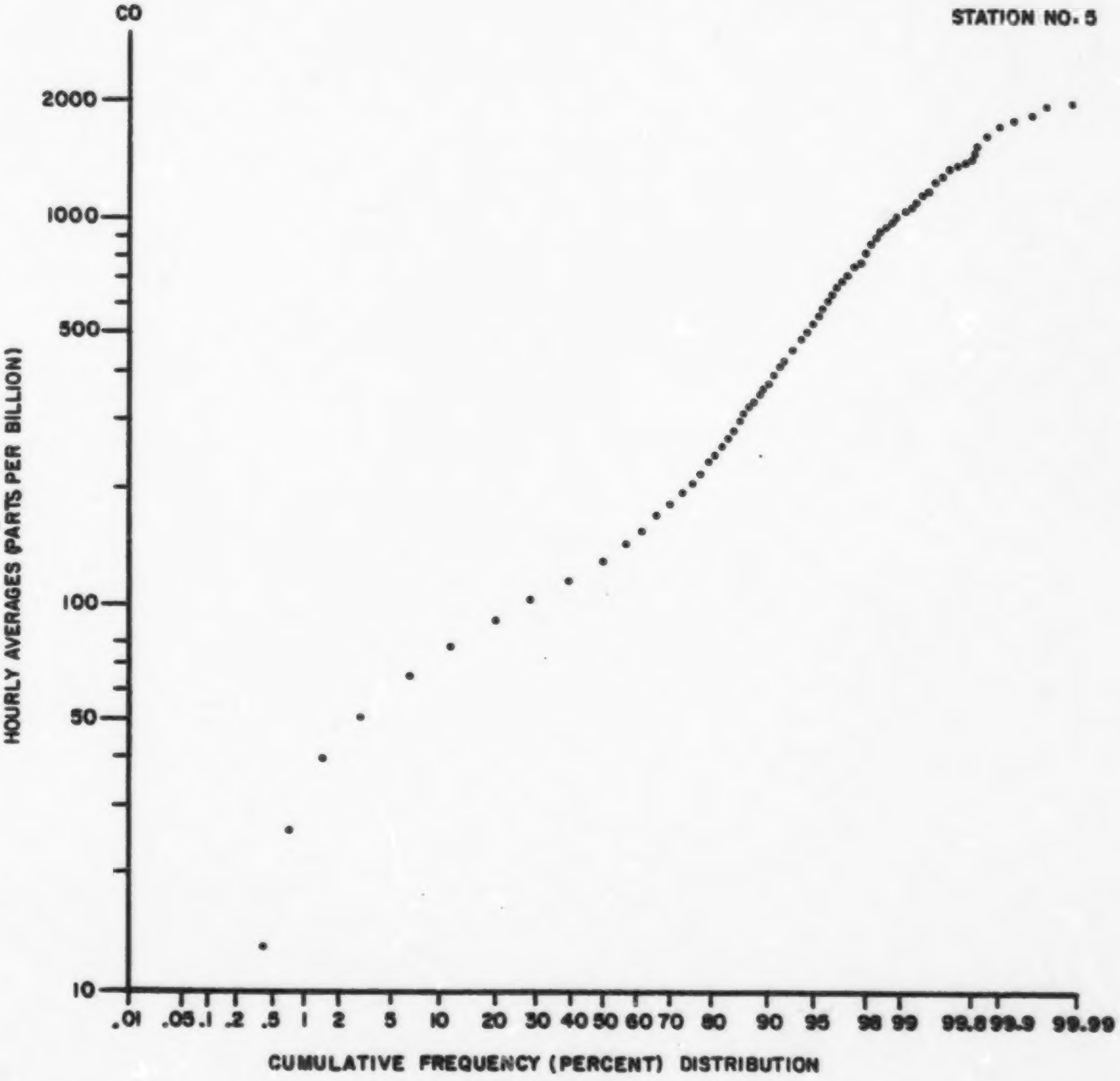


Figure K-5. Yearly cumulative frequency distribution for CO, station 5.

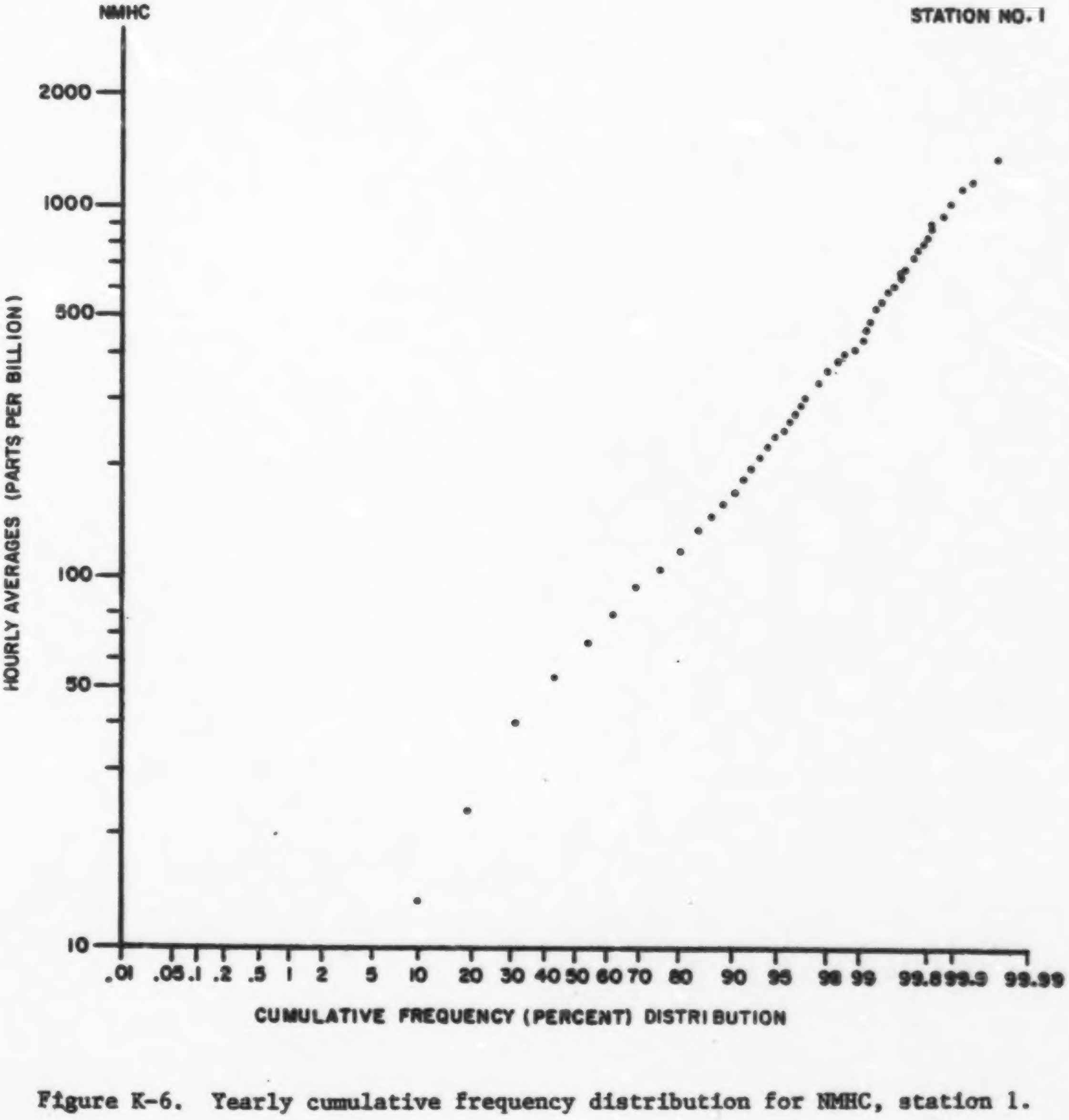


Figure K-6. Yearly cumulative frequency distribution for NMHC, station 1.

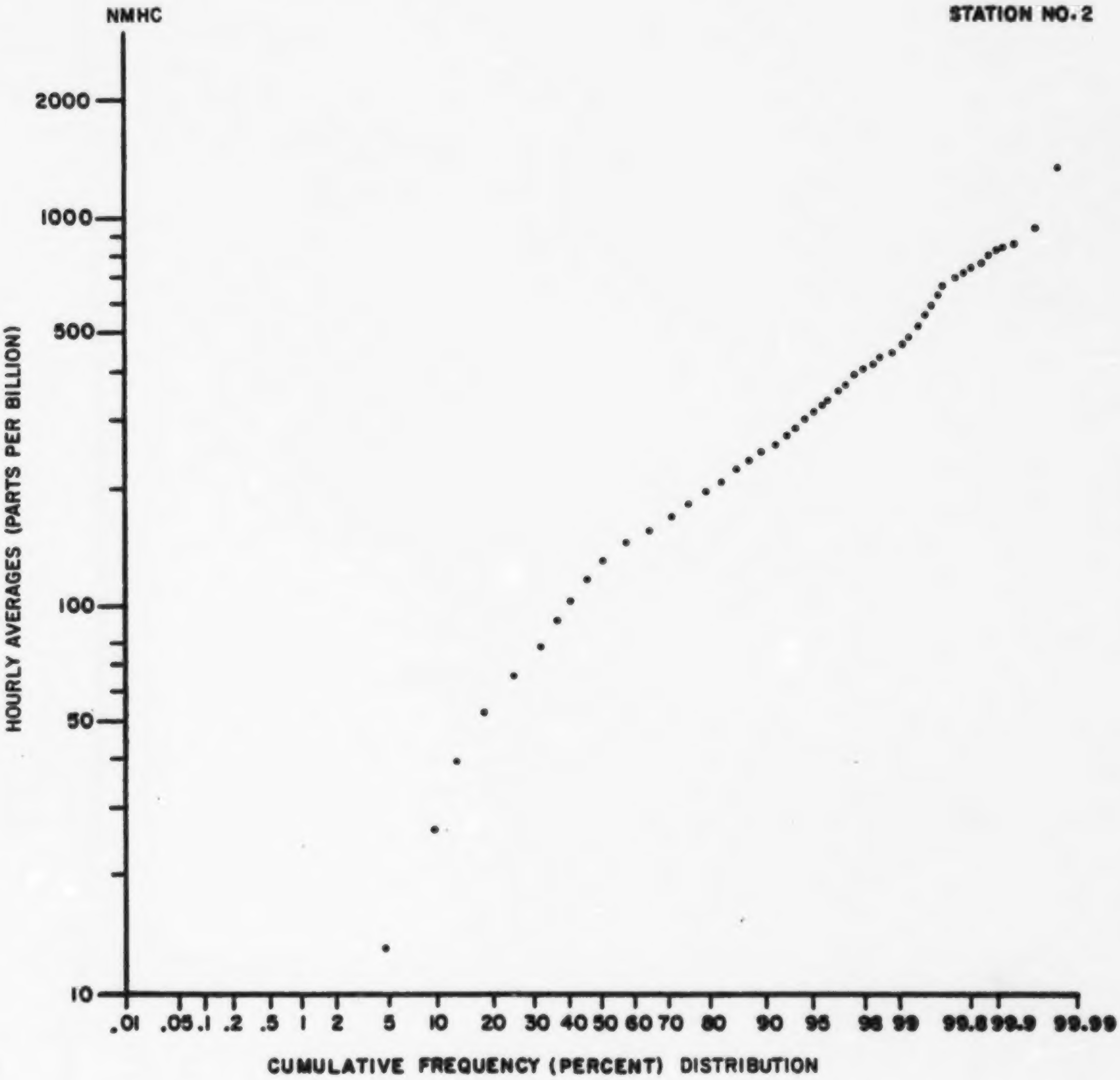


Figure K-7. Yearly cumulative frequency distribution for NMHC, station 2.

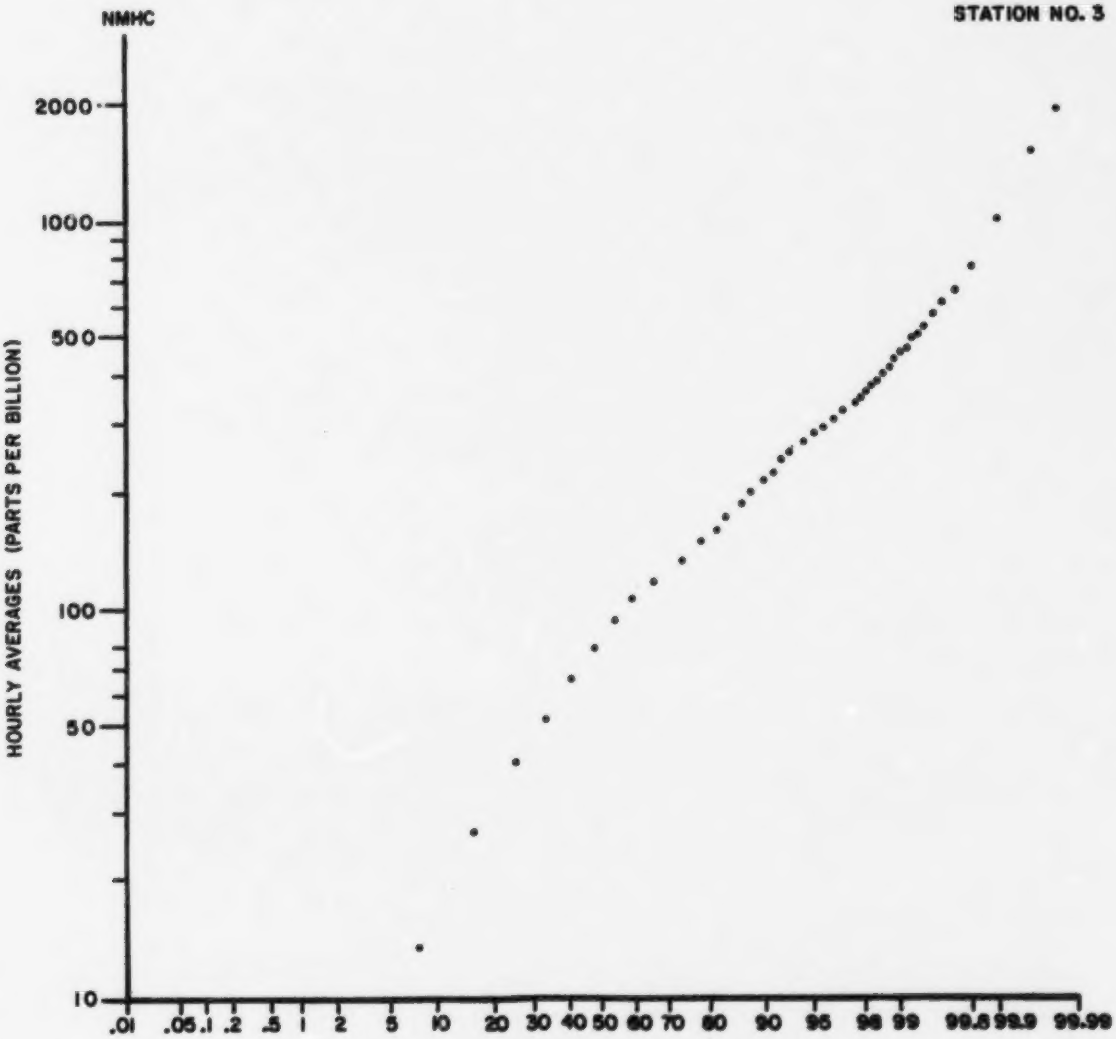


Figure K-8. Yearly cumulative frequency distribution for NMHC, station 3.

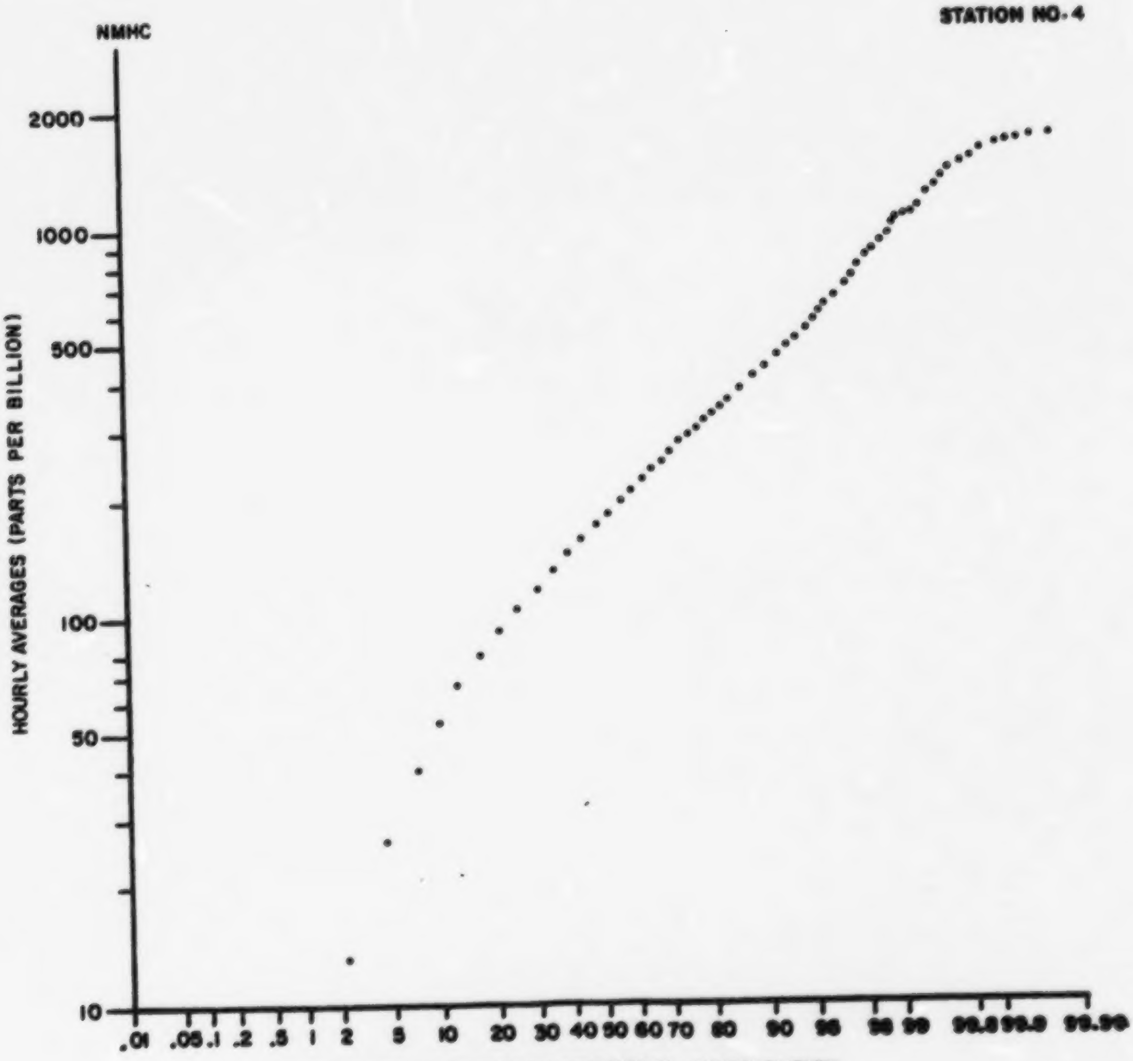


Figure K-9. Yearly cumulative frequency distribution for NMHC, station 4.

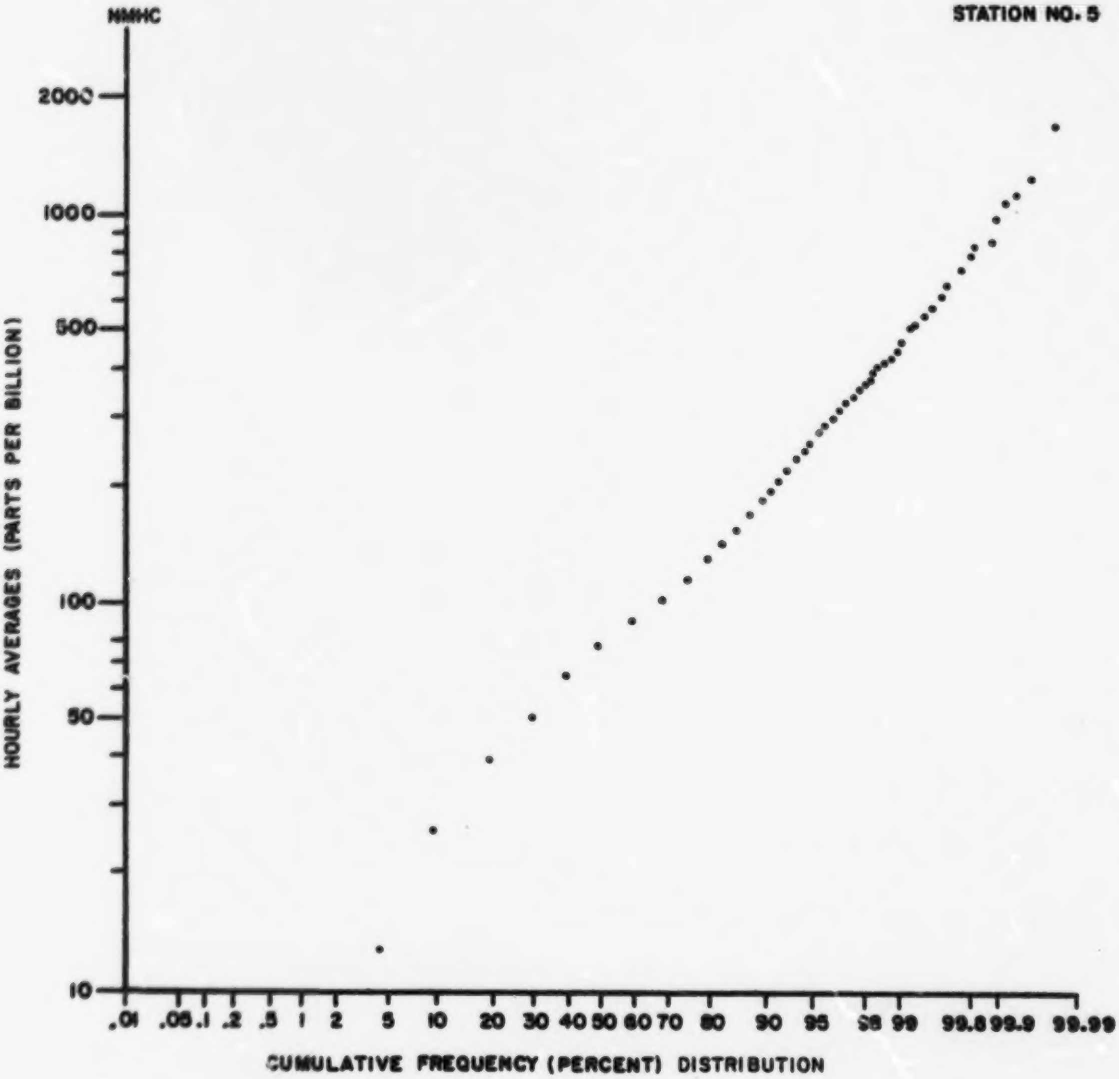


Figure K-10. Yearly cumulative frequency distribution for NMHC, station 5.

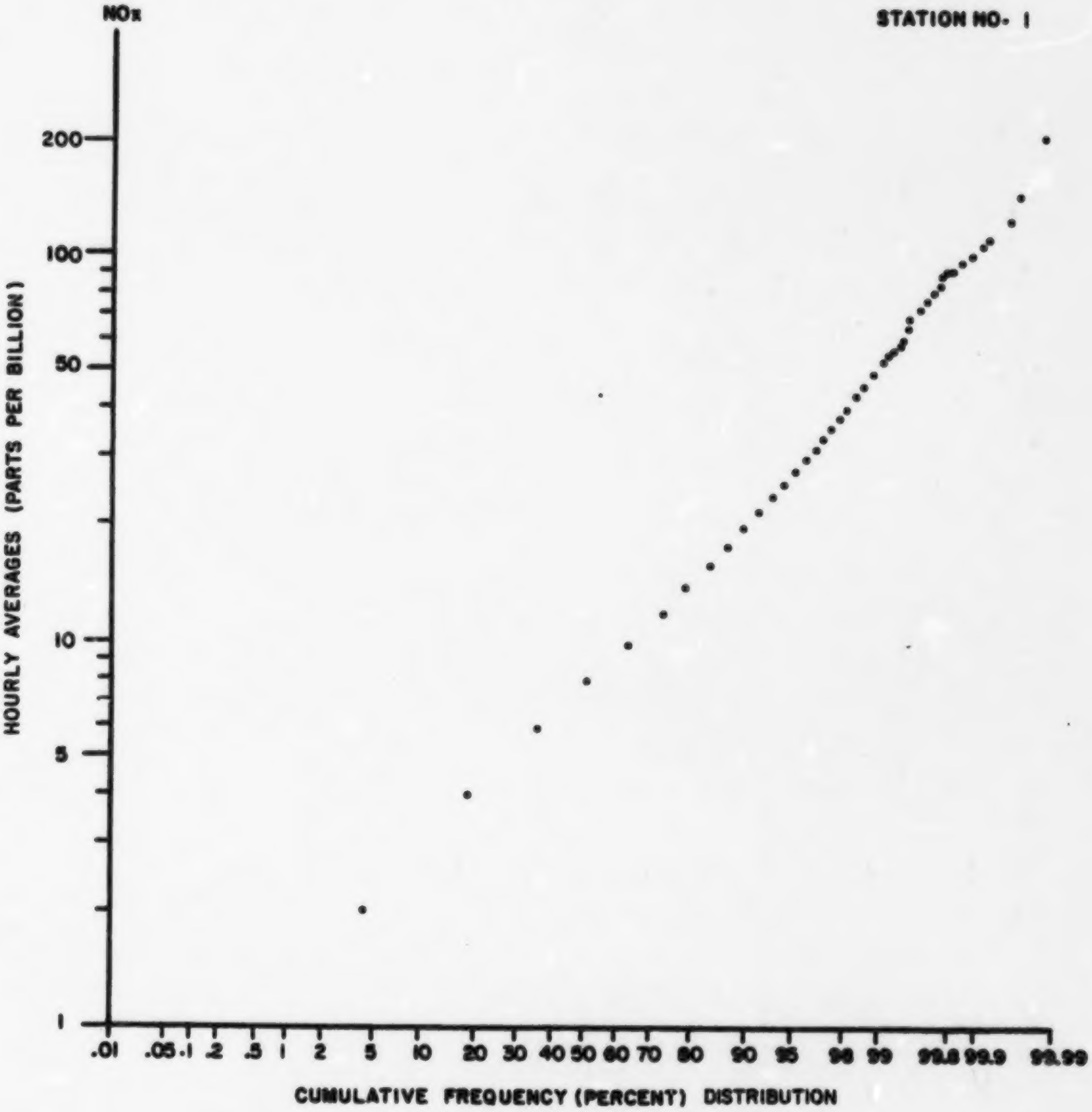


Figure K-11. Yearly cumulative frequency distribution for NO_x, station 1.

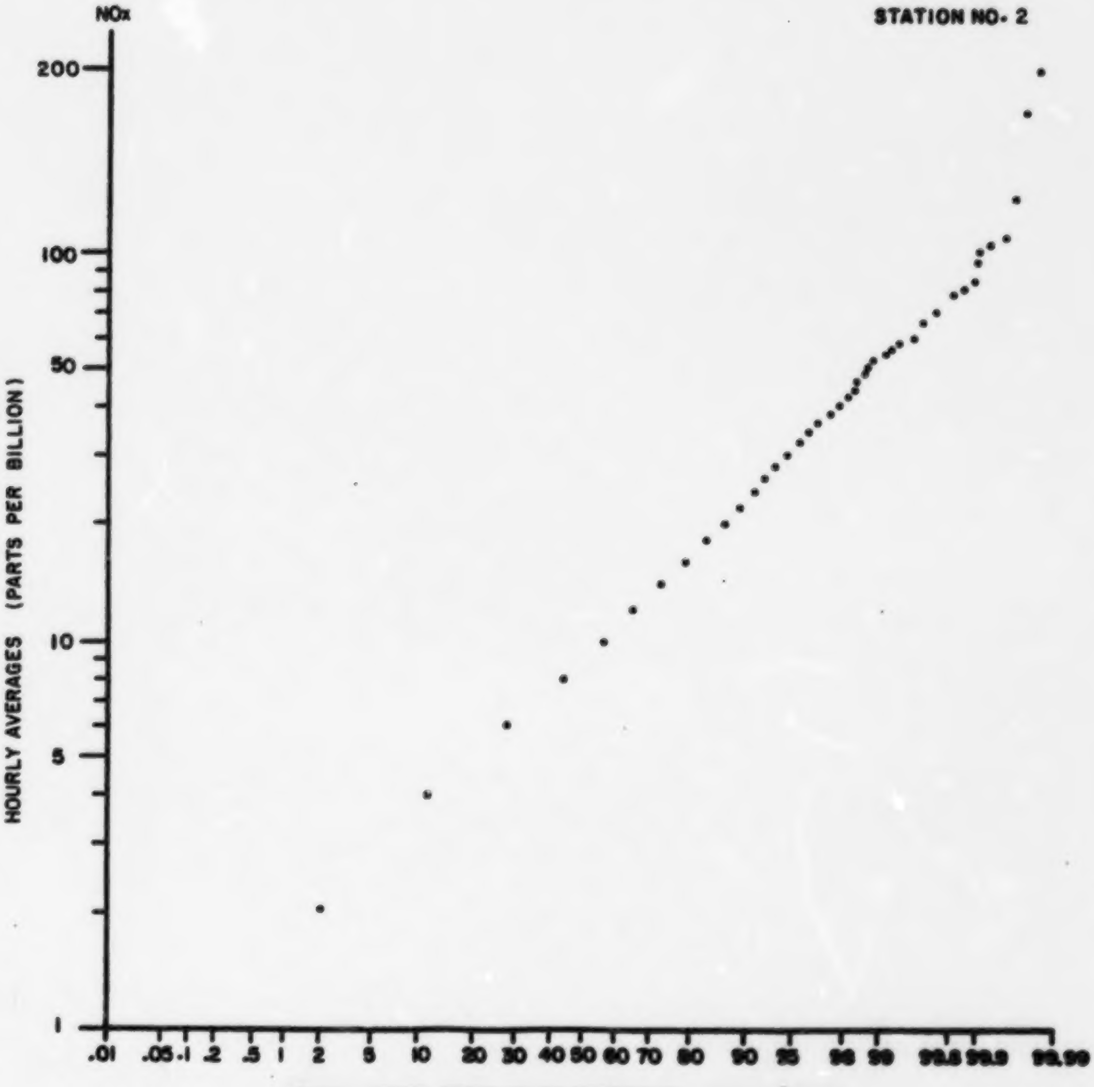


Figure K-12. Yearly cumulative frequency distribution for NO_x, station 2.

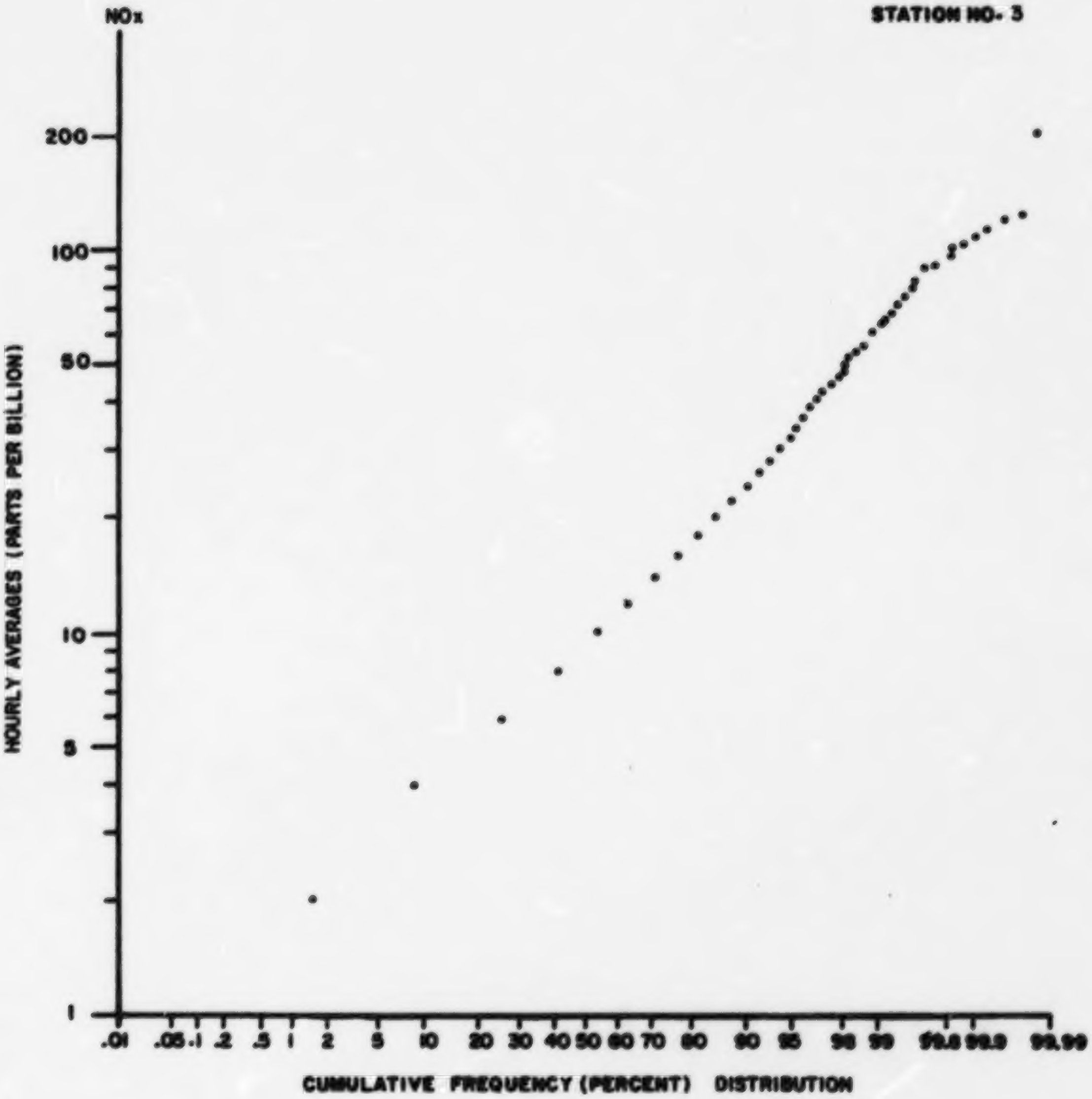


Figure K-13. Yearly cumulative frequency distribution for NO_x, station 3.

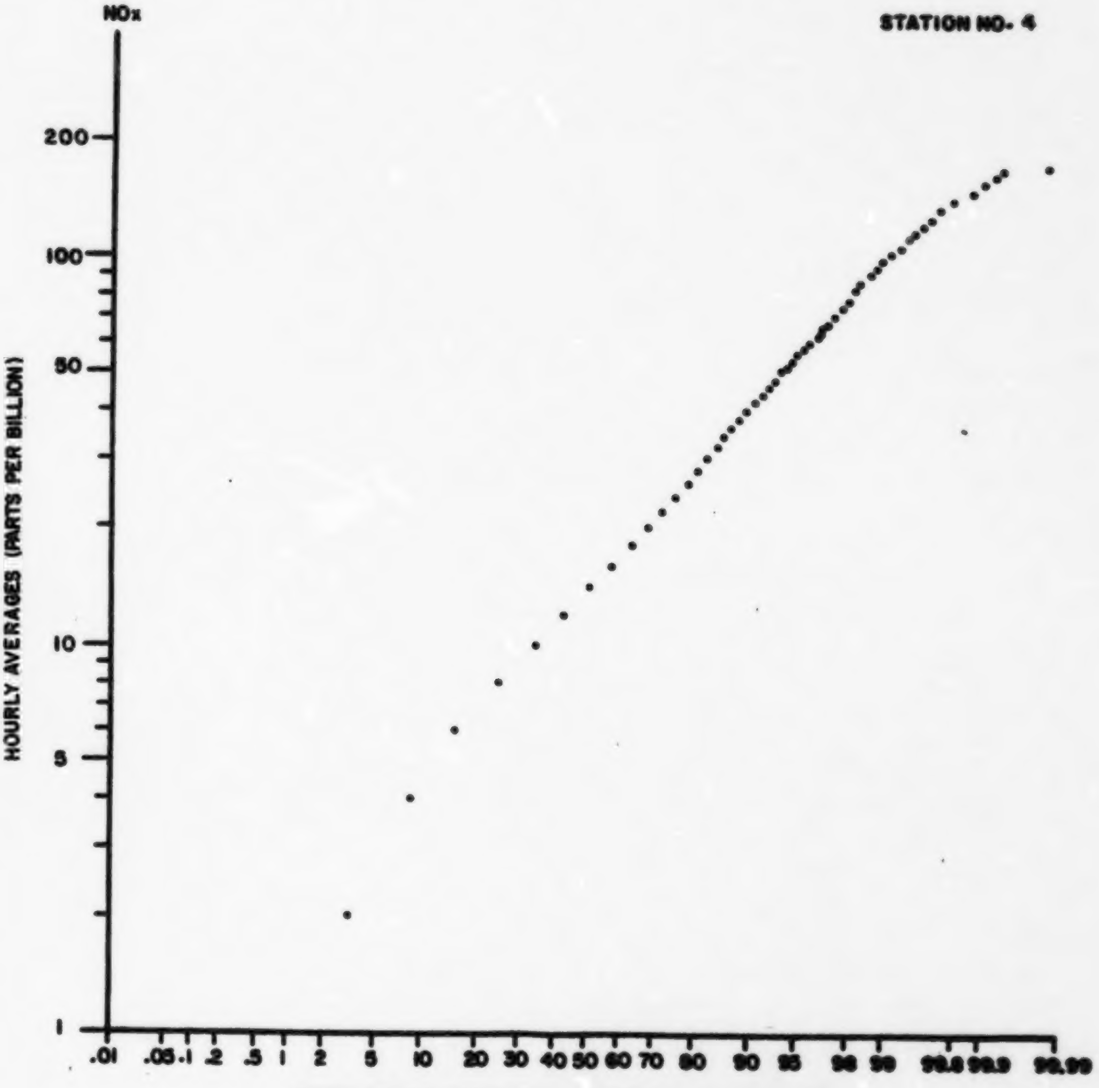


Figure K-14. Yearly cumulative frequency distribution for NO_x, station 4.

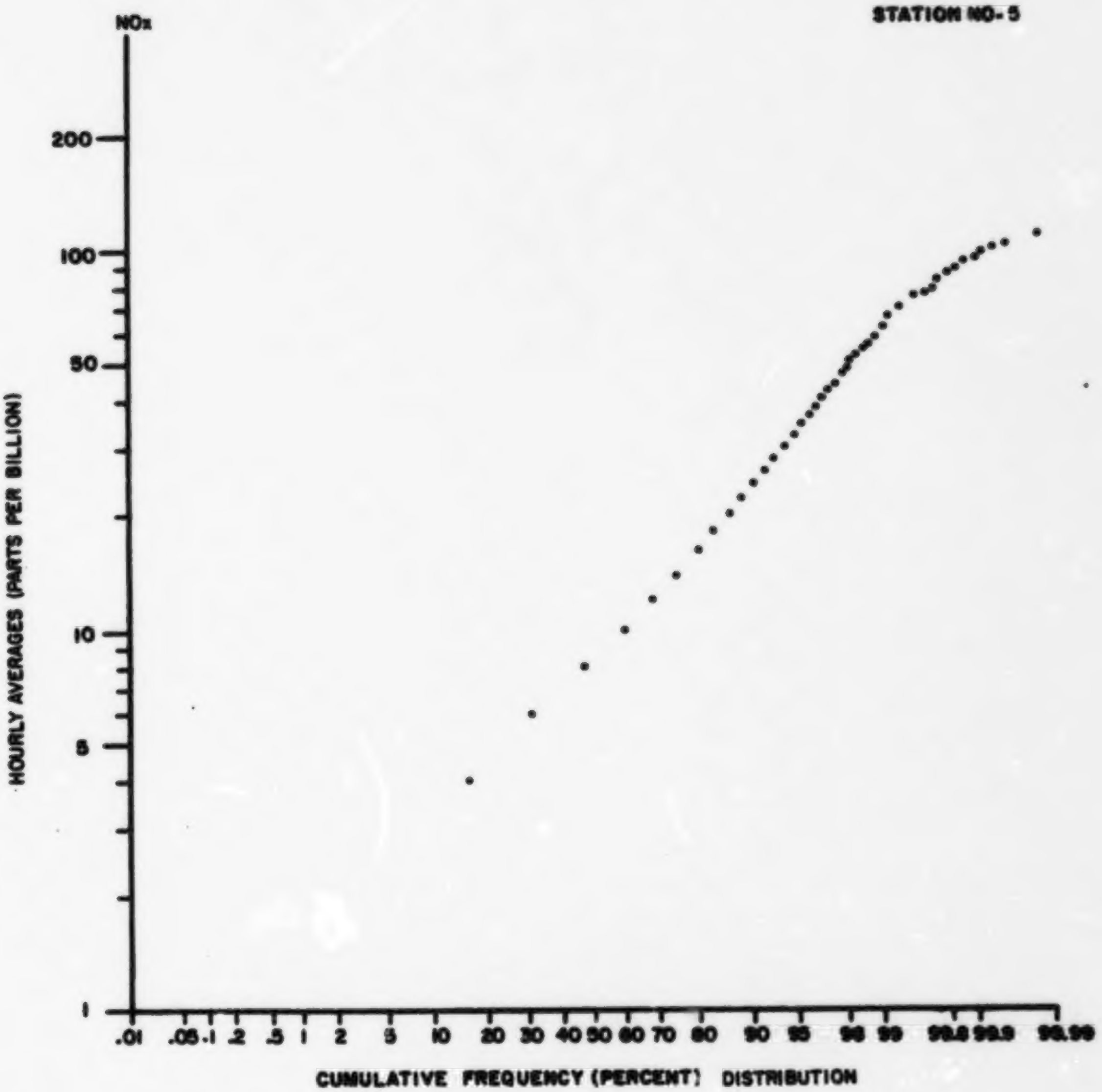


Figure K-15. Yearly cumulative frequency distribution for NO_x, station 5.

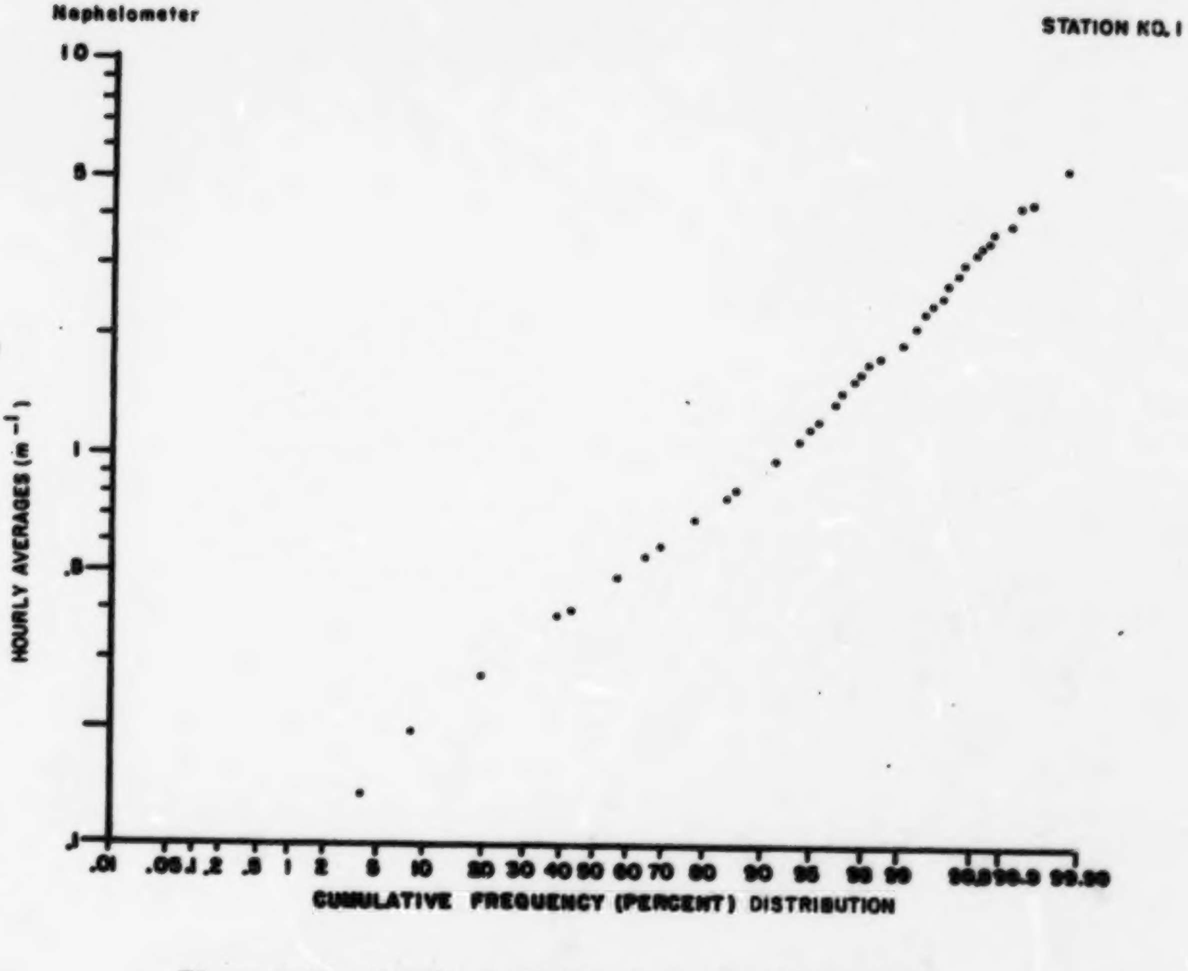


Figure K-16. Yearly cumulative frequency distribution for nephelometer, station 1.

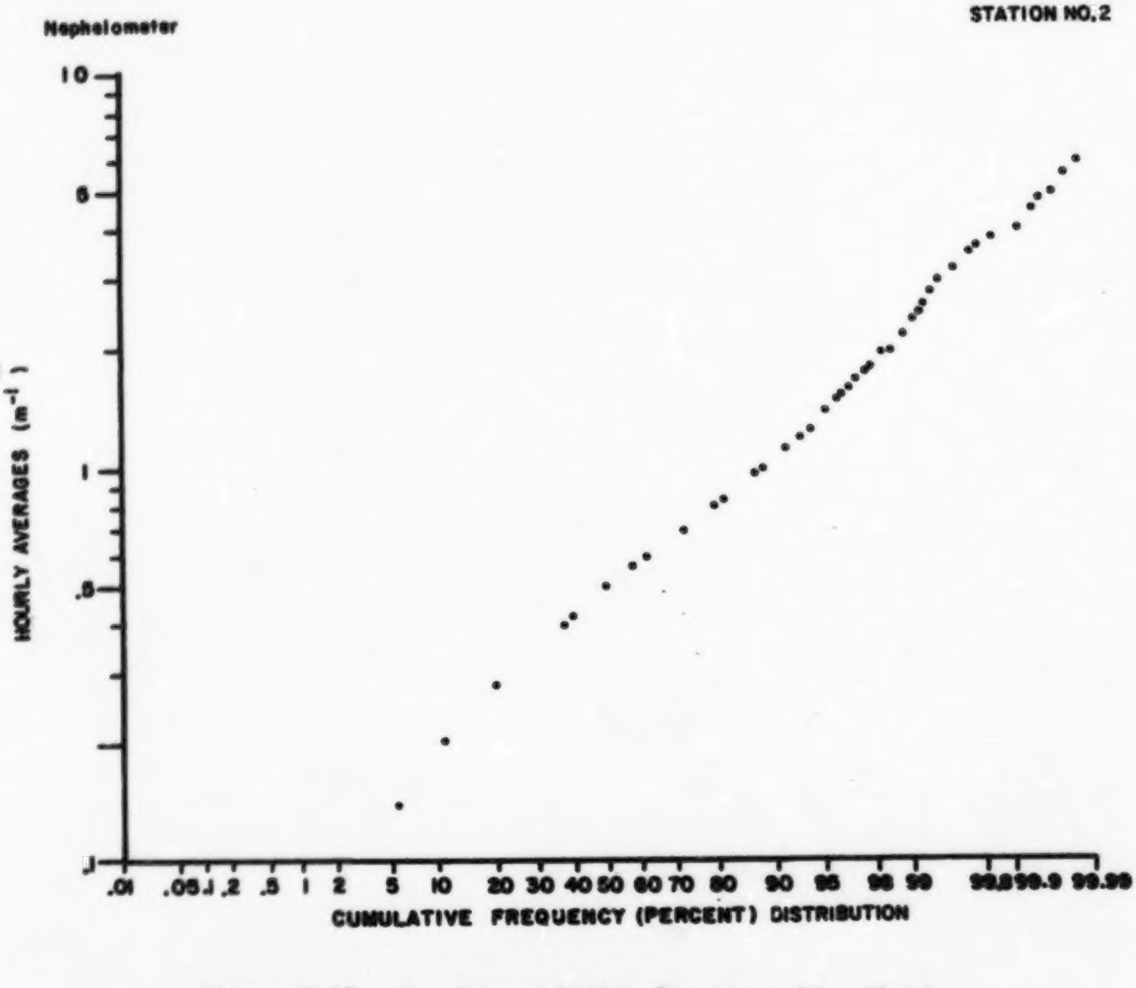


Figure K-17. Yearly cumulative frequency distribution for nephelometer, station 2.

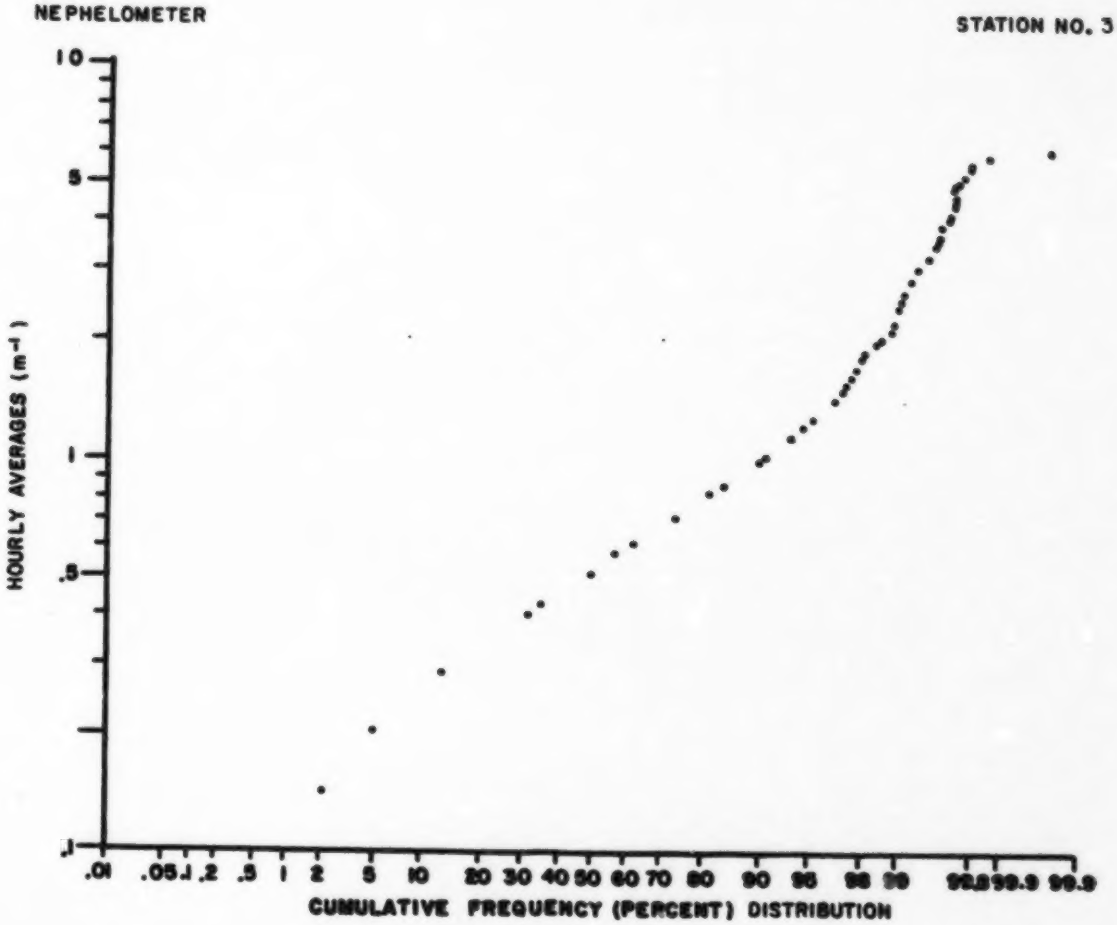


Figure K-18. Yearly cumulative frequency distribution for nephelometer, station 3.

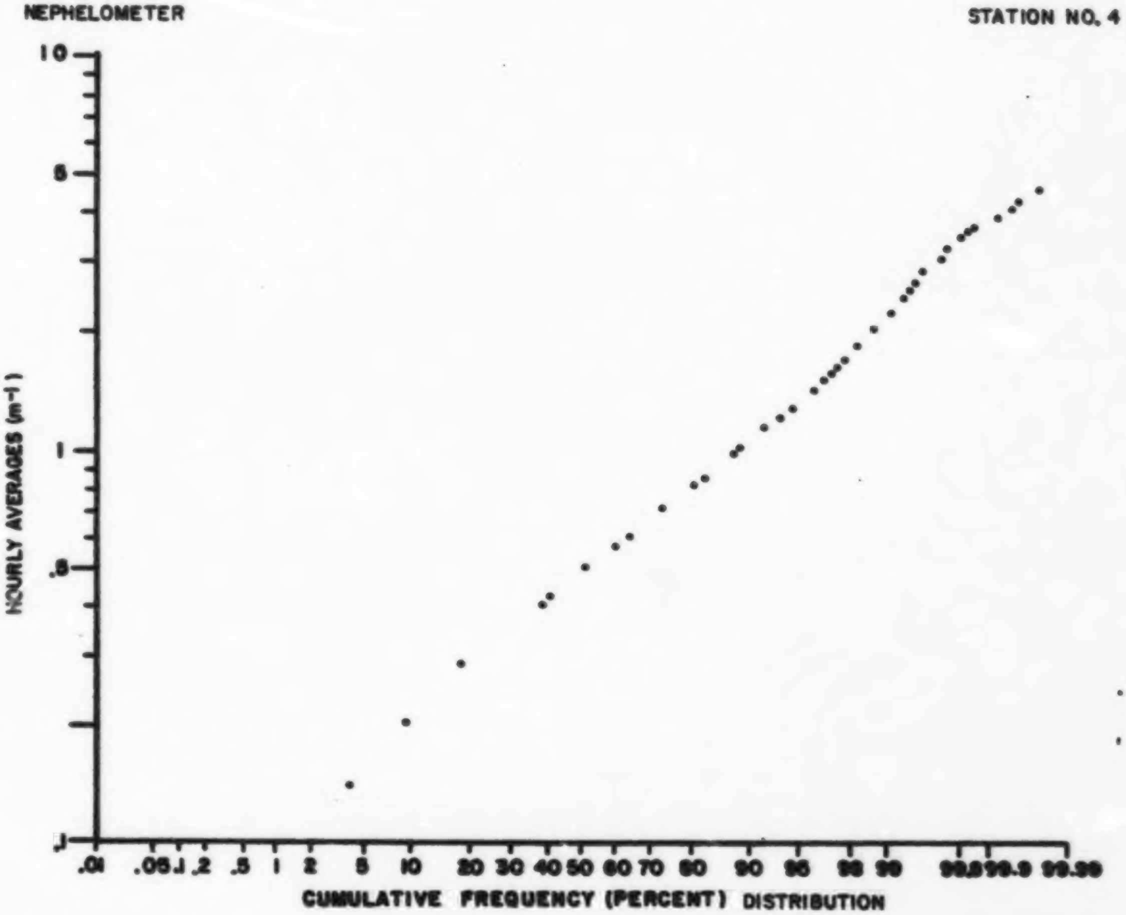


Figure K-19. Yearly cumulative frequency distribution for nephelometer, station 4.

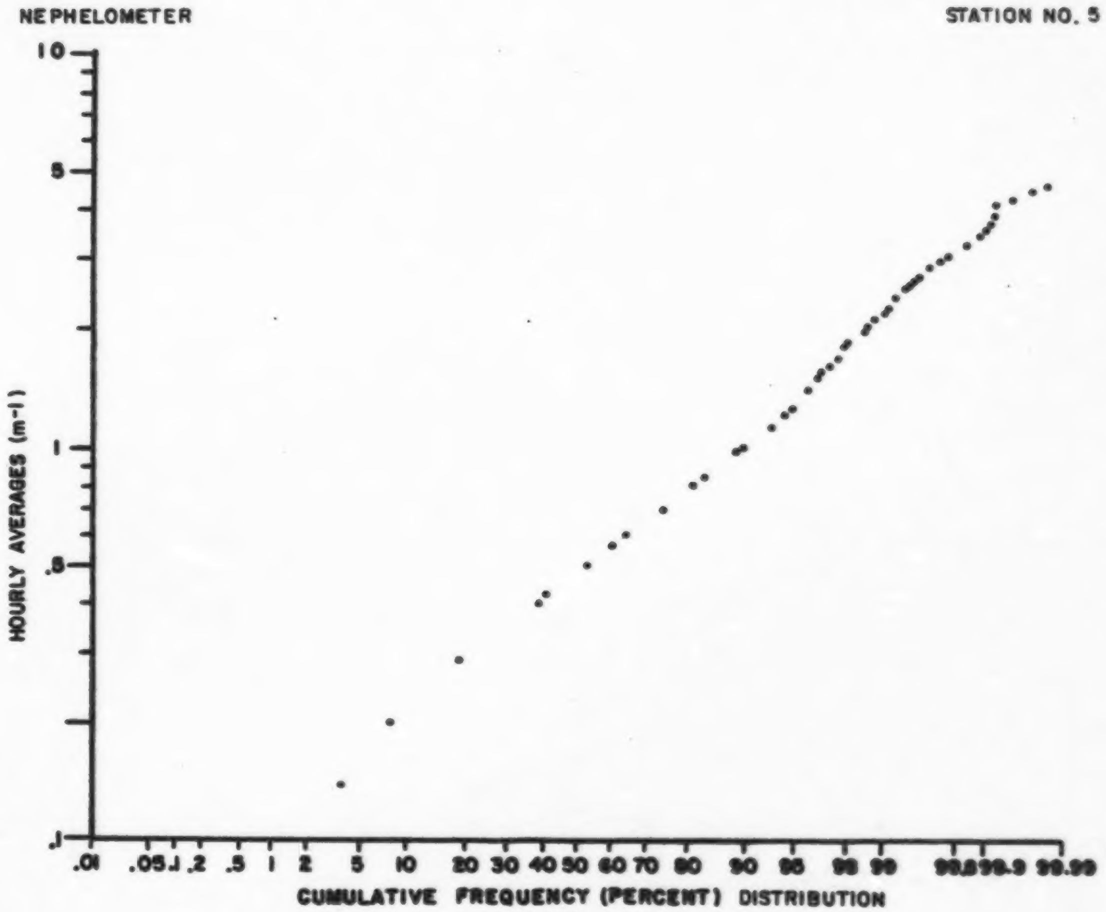


Figure K-20. Yearly cumulative frequency distribution for nephelometer, station 5.

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